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ART. XXXIV.—*Notices of Recent Earthquakes*, No. 5; by Professor C. G. ROCKWOOD, Jr., Rutgers College.

Jan. 6, 1874.—A shock was felt at Wolfboro, N. H.

Jan. 14, 1874.—The village of Saru-Kamush, thirty miles east of Harpoot, Turkey, "was entirely destroyed, and a good many houses in villages near by were thrown down."

Jan. 19, 1874.—A slight shock at San Francisco.

Jan. 26, 1874.—Two shocks at Manchester, N. H., at 2 and 5 A. M., the first light, the second heavy.

Feb. 10, 1874.—There began a series of disturbances in Bald and Stone Mountains, McDowell County, N. C., which continued at intervals for several months. The phenomena appear to have been occasional earthquake shocks, at no time violent, but accompanied by explosive and rumbling noises, and occurring, sometimes two or three in a day, and again with intervals of several days. These increased in frequency and intensity until the night of February 22, when the most severe shock was felt. About March 17 and 26, the shocks were again of some intensity, as also on April 14 and 17. A correspondent of the New York Evening Post, writing from Spartanburg, S. C., under date of March 23, and having just visited the affected region, reported experiencing a decided shock, with a deep rumbling noise, about sundown of March 18, and another on March 19, these being all that he felt during a five days' visit. Another observer says "the sounds resembled the re-

port made by blasting in a deep quarry or well, at first explosive and then reverberating." The shocks were most sensibly felt near the tops of the mountains, but were sometimes perceptible at distances of ten or fifteen miles, or even farther.

A paper by Gen. T. L. Clingman of North Carolina, on the volcanic character of this region, was read before the Washington Philosophical Society, July, 1874, and is noticed in this Journal, III, vol. ix, p. 55.

Feb. 12, 1874.—A shock at $6^h\ 30^m$ A. M. at Saco, Me.

Feb. 12, 1874.—Two shocks felt in the evening at Hilo, and also at Hamakua, Hawaii.

Feb. 15, 1874.—A shock at Copiapo, Chili.

Feb. 27, 1874.—A severe shock at $10^h\ 40^m$ P. M. at Bangor and Eastport, Me.

March 12, 1874.—A slight shock at Yarmouth, Nova Scotia.

March 12, 1874.—A slight shock at Sidney, N. S. W.

March 16, 1874.—An earthquake in Southern Mexico, stated to have been "very severe" in the province of Guerrero, but slight at the city of Mexico.

April 11, 1874.—The Japan Gazette of this date says "sharp shocks of earthquake had been felt at Hamaoa, causing great alarm."

April 18, 1874.—A shock at St. Thomas, W. I.

May 3, 1874.—Letters from the Harpoot Mission, Eastern Turkey, under date of May 8, say: "Last Sabbath morning (May 3), at seven o'clock, a severe shock of earthquake was felt here and in all the plain. Houses fell in several villages, but at Haboosi, in the eastern part of the plain, the effect was disastrous." Again, under date of May 16: "The village of Haboosi, twelve miles from here, with a population of 2,500, was reduced to a heap of ruins in one minute of time, and twenty persons were killed. Not more than three or four houses are left standing. The large flat earthen roofs were thrown upon adjoining buildings, and the ruins are so commingled that it is not easy for the inhabitants to tell where are the foundations of their own houses. In other villages the disaster has been very serious, and we fear the end is not yet. Shocks continue daily."

May 5, 1874.—A sharp shock about midnight at Callao, Peru.

May 14, 1874.—A series of severe shocks about 9 A. M. at Hilo, Hawaii, and the adjacent coast. "Simultaneously with this earthquake the crater of Kilauea became more brilliant and active."

May 24, 1874.—Two sharp shocks about 2 A. M. at San Francisco.

June 11, 1874.—Two sharp shocks at 8 P. M. at San Francisco. No damage done.

June 17, 1874.—A slight shock at 12 P. M. at Salt Lake City. "There were several vibrations, the shock continuing for about ten seconds. It was plainly felt at Alta and at Granite, where a rumbling noise was also heard."

June 18, 1874.—A shock at Guayaquil, Ecuador.

June 23, 1874.—A severe shock about $9^h\ 25^m$ A. M. at Hong Kong, China. "The rumbling and trembling of the earth lasted fully fifteen seconds." The harbor was much disturbed, bells were rung and two small houses were thrown down.

June 27, 1874.—"Strong shocks" at Constantinople, Turkey.

July 7, 1874.—A strong shock at $2^h\ 7^m$ A. M at Valparaiso, Chili.

July 9, 1874.—A slight shock about 4 P. M. at Cairo, Ill.

July 26, 1874.—A shock at Vienna, Austria.

Aug. 8, 1874.—A shock in the morning at Valparaiso.

Aug. 8, 1874.—A severe shock at noon at St. Thomas, St. Kitts and Antigua, W. I.

Aug. 17, 1874.—A slight shock at Demerara, Trinidad and Grenada.

Aug. 20, 1874.—A severe shock at Yokohama, Japan.

Aug. 26, 1874.—A severe shock in the morning at Puerto Rico. "Vibrations lasted two minutes; houses rocked."

Sept. 3, 1874.—A destructive earthquake occurred in Guatemala, centering near the Volcan del Fuego. Advices from Antigua state that, since the beginning of August, slight shocks had been felt, becoming more frequent toward the end of the month. From Aug. 27, the town of Duenos, and other places near the volcano named, felt shocks at short intervals, accompanied by subterranean noises. On the night of Sept. 3, about 9 P. M. (one account says $8^h\ 30^m$, another $9^h\ 18^m$), the most violent shock occurred. The movement was a series of vertical and horizontal impulses combined; the direction was west to east, as noted by a swinging lamp. The shock was stated by one observer as lasting twenty-five or thirty seconds; by another as continuing in its intensity during four seconds and then gradually diminishing. Sounds like thunder were heard from the earth. Many other less violent shocks were felt during the night, the principal one at 2 A. M. In Antigua the church bells were rung by the vibration, about two dozen inhabited houses were destroyed and thirty-two lives lost. The town of Duenos was entirely ruined, and some persons were killed there and in neighboring villages. An eruption of cold compact mud issued from the heights of Cerro del Tigre, a small mountain at the base of the Volcan del Fuego, and which appears to have been the center of disturbance.

Sept. 26, 1874.—In connection with the eruption of Mt. Etna, which began Aug. 29, an earthquake occurred extending to the village of Randozza, and destroying several houses.

Oct. 7 and 12, 1874.—Severe shocks and subterranean noises near Mazatlan, Mexico.

Oct. 26, 1874.—An "unusually heavy" shock in Chili about $0^h\ 12^m$ A. M. Its duration was about thirty seconds and direction east to west. The Director of the National Observatory reports that it was followed by a rise of 2°·2 of the thermometer.

Nov. 11, 1874.—Trembling and subterranean rumbling at Guanajuato, Mexico. Many houses injured.

Nov. 12, 1874.—A slight shock about 10 P. M. at Virginia City, Nev.

Nov. 13, 1874.—Two shocks, each lasting ten seconds, were felt at Vera Cruz, and along the Mexican coast. Several houses were destroyed. Shocks continued to be felt at intervals for at least ten days.

Nov. 13, 1874.—A slight shock at Guayaquil, Ecuador.

Nov. 24, 1874.—A slight shock at Salem, Newburyport and throughout Essex County, Mass. Direction west to east.

Nov. 29, 1874.—Two heavy shocks at Oreana, Nev.

Dec. 10, 1874.—A somewhat severe shock was felt throughout Westchester and Rockland Counties, N. Y., and Bergen County, N. J. It extended as far as Peekskill on the north and Norwalk, Conn., on the east. The time is stated generally as half-past ten P. M. (one observer giving $10^h\ 23^m$). The duration is variously estimated from three seconds to one minute, the majority, however, putting it at five or six seconds. The direction of the vibration appears to have been from northwest to southeast, the reports being about equally divided between west, northwest and north, only one observer giving northeast. The shock was most severe in the neighborhood of Tarrytown and Nyack, but did no damage anywhere. It was at all places accompanied by subterranean noises, which are described as a long rumble ending with a violent explosion.

Jan. 7, 1875.—A shock at Valparaiso, Chili.

Jan. 18, 1875.—A shock in Ecuador.

Feb. 7, 1875.—Three shocks at San Francisco, the first about 2 A. M., the second at $10^h\ 45^m$ A. M., lasting two seconds, with the motion vertical and vibrations north and south; the third at $11^h\ 45^m$ A. M., not so heavy as the preceding.

Feb. 9, 1875.—Three slight shocks at Preston, Conn., not felt across the river in Norwich.

Feb. 11, 1875.—An earthquake at Guadalajara, Mexico, extending to San Cristabal and destroying houses in both places.

March 10, 1875.—A shock at 12 M. in the vicinity of Issequena, Goochland County, Va.

My thanks are due to John M. Batchelder, Esq., of Boston, for information received.

New Brunswick, N. J., March 20, 1875.

ART. XXXV.—*On Dr. Koch's Evidence with regard to the Cotemporaneity of Man and the Mastodon in Missouri;* by JAMES D. DANA.

THE evidence of the cotemporaneity of Man and various extinct Quaternary Mammals in Europe and Great Britain is complete: that is, it is beyond reasonable doubt or question; for (1) it has been gathered with great care by the best of geological observers; (2) it has been verified through the re-examinations of reported cases by other able geologists; and (3) it has been further verified by the special investigations of committees of scientific societies.

The North American facts thus far announced have not, unfortunately, the same broad basis for confidence.

Among the earlier of the reported discoveries are the two in Missouri, brought out by Dr. Koch. The account of them has often been cited by writers on the subject; and Mr. J. W. Foster, in his "Pre-Historic Races of the United States of America," prefixes to the citation the remark that Dr. Koch, at an interview with him, during the last year of his life, assured him, "in the most solemn and emphatic manner, that his statement was true." Mr. Foster also observes that "to deny the accuracy of his statement is to accuse him of having attempted to perpetrate a scientific fraud,"—a decision not sustained by the ordinary rules or treatment of evidence; for Science has constantly to guard itself against the assertions of men who are honest, but are not experienced in scientific investigation, and, in all such cases, rightly asks for corroborating testimony. Moreover, Dr. Koch's statement of his facts may be true, and still his conclusion as to their proving the cotemporaneity of Man and the Mastodon in North America be wrong.

The question which American Science should carefully consider — as carefully and guardedly as has been done for similar cases in Europe — is, whether Dr. Koch was a competent observer, and whether his observations are a sufficient basis for the conclusion that has been drawn from them.

I have before me four pamphlets by Dr. Koch, dated, severally, 1841, 1843, 1845 and 1853. They relate to his discoveries in this country — the first two of them to his *Missourium*, and the others to his *Hydrarchos*, or, as these publications call it,—his *Hydrargos*, or species of *Hydrachen*. The following are copies of their title pages, commencing with the earliest:

Description of the MISSOURIUM, or MISSOURI LEVIATHAN, together with its supposed habits; Indian traditions concerning the

location from whence it was exhumed; also, comparisons of the Whale, Crocodile, and Missourium with the Leviathian, as described in the 41st Chapter of the Book of Job; by Albert Koch. 16 pp. 8vo. St. Louis, 1841. [1840 on the cover, indicating that the copy is from a second edition.]

Description of the MISSOURIUM THERISTOCAULODON (Koch), or MISSOURI LEVIATHAN (Leviathan Missouriensis), together with its supposed habits and Indian traditions; also, comparisons of the Whale, Crocodile and Missourium with the Leviathan, as described in the 41st Chapter of the Book of Job; by Albert Koch. Fifth edition enlarged. 28 pp. 8vo. Dublin, 1843. [A "third edition" of 24 pages appeared in London in 1841.]

HYDRARGOS, or GREAT SEA SERPENT OF ALABAMA, 114 feet in length, 7,500 lbs. weight, now exhibiting at the Apollo Saloon, 410, Broadway. Admittance 25 cents.—Description of the HYDRARGOS SILLIMANII (Koch). A gigantic fossil Reptile, or SEA SERPENT: lately discovered by the author in the State of Alabama, March, 1845. Together with some geological observations made on different formations of the rocks during a geological tour through the Eastern, Western and Southern parts of the United States, in the years 1844–1845; by Doctor Albert C. Koch, Corresponding Member of the Societies of Halle, and of Dresden, &c. 16 pp. 8vo. New York, 1845. [Following this, Dr. Koch published at Berlin, in 1845, a book of 99 pages, with 8 plates, entitled "Die Riesenthiere d. Urwelt," giving an account of his Mastodontoid discoveries in America.]

Description of the family of Animals now extinct, but known to the scientific world under the appellation of HYDRACHEN:* these animals, when living, were the most gigantic, powerful and horrible beasts of prey that ever ruled over and spread terror through the primitive Oceans; also an account of the discovery of the ZEUGLODON MACROSPONDYLUS of Müller, and of the remains of Hydrachen in general; by Dr. Albert Koch, Corresponding Member of various Scientific societies. 12 pp. 8vo. New Orleans, 1853.

The *first* of these pamphlets was printed when the MISSOURIUM was on exhibition at St. Louis in 1840, 1841; the *second*, when the skeleton was in Ireland, it having been taken to London in 1841; the *third*, when Dr. Koch's first collection of ZEUGLODON remains was arranged and on exhibition as the "Hydrargos" in New York; the *fourth*, after this first Zeuglodon collection had been carried (in 1845) to Europe, and purchased (in 1847) for the Royal Anatomical Museum at Berlin

* In this change of name from *Hydarchos*, the *Water-Chief* (the suggestion, no doubt, of some friend, since he never wrote it right), to *Hydrachen*, a word that looks as if made up from the Greek word for *water* and the German for *dragon*, Dr. Koch evidently intended to adopt Müller's German term for the family, *Hydrarchen*.

(where it was studied by Müller); and after another "Hydrargos" had been obtained by Dr. Koch (in 1848), in the vicinity of "Washington Old Court House, Washington Co., Alabama," and had been transported (1) to Dresden (where, through "eight months' faithful labor," it was set up by the 6th of May, 1849), and also (2) to Breslau, (3) to Vienna (1850), and (4) to Prague, and at each place put on exhibition; but not to Munich, because "the only saloon disposable was too small for the exhibition;" and, finally, had come back to its native country, "after it had established its just fame in Europe" as one of the "Hydrachen," and been put on exhibition in New Orleans.*

Still other accounts of earlier date are at hand in this Journal, vols. xxxvi and xxxvii of 1839; the *first* (vol. xxxvi, p. 198) cited from a newspaper article of January, 1839, which was evidently written by Dr. Koch (then Mr., the title of Doctor appearing first in 1845); the *second* (vol. xxxvii, p. 191), signed "A. Koch, *Proprietor of the St. Louis Museum*," and credited to the "St. Louis Com. Bulletin of June 25," 1839.

Further, a note on the bones at St. Louis collected by Mr. Koch was presented to the American Philosophical Society, in October, 1840, by Dr. W. E. Horner, and an abstract from the Proceedings of that Society is cited in vol. xl, (1841) of this Journal.

It is evident from these documents that Dr. Koch was a man of enterprise, "an indefatigable collector." The credit is also due him of having performed a great service to science by his collections; for these included one of the best skeletons of the Mastodon that has been unearthed and two nearly complete skeletons of Zeuglodon, besides portions of other Mastodon and Zeuglodon individuals. Dr. Koch's "St. Louis Museum" contained, in 1840, according to Dr Horner, "200 or more teeth of the Mastodon and American Elephant, a dozen or more lower jaws of the Mastodon, with very numerous specimens of other parts of the head and skeleton generally, though no perfect head;" "the skeleton nearly complete of a Mastodon;" and, besides, "the head of an animal which Mr. Koch calls nondescript," which Dr. Horner thought to be that of a Mastodon, and another interesting Mastodon relic, "denominated by the proprietor (Dr. Koch) *Missourium Kochii*."

The two cases of the discovery of human remains along with those of the Mastodon, mentioned by Dr. Koch, are described in the pamphlets published in London and elsewhere abroad; in the Transactions of the St. Louis Academy, vol. i, p. 61, 1857;

* The skeleton was on exhibition in St. Louis as early as 1855 or 1856, as stated in this Journal, II, xxi, 146, 1856; was there, as I learn from Dr. Lapham, sold to the Museum (Curiosity shop); and thence, later, taken to Wood's Museum in Chicago, where it ended its remarkable career in the great fire of 1871.

and the *first* of the cases at an earlier date in a newspaper article of January, 1839, cited in vol. xxxvi of this Journal (1839). This earliest account was written by Dr. Koch himself, the discoverer, for it is all in the *first* person; and, as it appeared within a few months of the discovery, it best deserves citation. It is therefore here republished, and after it, that of the *second* case, from the pamphlet of 1843.

I. "It is with the greatest pleasure the writer of this article can state, from personal knowledge, that one of the largest of these animals has actually been stoned and buried by Indians, as appears from implements found among the ashes, cinders, and half burned wood and bones of the animal. The circumstances are as follows:

"A farmer in Gasconade County, Missouri, lat. 38°20′ N., lon. 92° W., wished to improve his spring, and in doing so, discovered, about five feet beneath the surface, a part of the back and hip bone. Of this I was informed by Mr. Wash [Walsh, in pamphlet of 1843], and not doubting but the whole, or nearly the whole skeleton might be discovered, I went there and found as had been stated, also a knife made of stone. I immediately commenced opening a much larger space; the first layer of earth was a vegetable mould, then a blue clay, then sand and blue clay. I found a large quantity of pieces of rocks, weighing from two to twenty-five pounds each, evidently thrown there with the intention of hitting some object. It is necessary to remark, that not the least sign of rocks or gravel is to be found nearer than from four to five hundred yards; and that these pieces were broken from larger rocks, and consequently carried here for some express purpose. After passing through these rocks, I came to a layer of vegetable mould; on the surface of this was found the first blue bone, with this a spear and axe; the spear corresponds precisely with our common Indian spear, the axe is different from any one I have seen. Also on this earth was ashes, nearly from six inches to one foot in depth, intermixed with burned wood, and burned bones, broken spears, axes, knives, &c. The fire appeared to have been the largest on the head and neck of the animal, as the ashes and coals were much deeper here than in the rest of the body; the skull was quite perfect, but so much burned, that it crumbled to dust on the least touch; two feet from this, was found two teeth broken off from the jaw, but mashed entirely to pieces. By putting them together, they showed the animal to have been much larger than any heretofore discovered.

"It appeared by the situation of the skeleton, that the animal had been sunk with its hind feet in the mud and water, and unable to extricate itself, had fallen on its right side, and in that situation was found and killed as above described, consequently the hind and fore foot on the right side, was sunk deeper in the mud, and thereby saved from the effects of the fire; therefore I was able to preserve the whole of the hind foot to the very last joint, and the

fore foot all but some few small bones, that were too much decayed to be worth saving. Also between the rocks that had sunk through the ashes, was found large pieces of skin, that appeared like fresh tanned sole leather, strongly impregnated with the ley from the ashes, and a great many of the sinews and arteries were plain to be seen on the earth and rocks, but in such a state as not to be moved, excepting in small pieces, the size of a hand, which are now preserved in spirits.

"Should any doubts arise in the mind of the reader, of the correctness of the above statement, he can be referred to more than twenty witnesses, who were present at the time of digging."—*This Journal*, 1839, xxxvi, 198.

The statements respecting this discovery in the pamphlet of 1843 agree in the main with the above. There is the additional information that the excavation took place in October, 1838; and that the locality was within 300 yards of the Burbois (rightly Bourbeuse) River; but nothing is said of the "large pieces of skin that appeared like fresh tanned sole-leather strongly impregnated with the ley from the ashes," or of "the sinews and arteries" that "were plainly to be seen on the earth and rocks," portions of "which are now preserved in spirits."

II. "The second trace of human existence with these animals, I found during the excavation of the Missourium. There was embedded, immediately under the femur or hind leg bone of this animal, an arrow-head of rose-coloured flint, resembling those used by the American Indians, but of a larger size. This was the only arrow-head immediately with the skeleton: but in the same strata at a distance of five or six feet, in a horizontal direction, four more arrow-heads were found; three of these were of the same formation as the preceding; the fourth was of very rude workmanship. One of the last mentioned three was of agate, the others of blue flint. These arrow-heads are indisputably the work of human hands. I examined the deposit in which they were embedded, and raised them out of their embedment with my own hands.

"The original stratum on which this river flowed at the time it was inhabited by the Missourium Theristocaulodon (and up to the time of its destruction), was of the upper green sand. On the surface of this stratum, and partly mingled with it, was the deposit of the before-described skeleton. The next stratum is from three to four feet in thickness, and consisted of a brown alluvium of the *Eocene* region, and was composed of vegetable matters of a tropical production—it contained all the remainder of the skeleton.

"Most of these vegetables were in a great state of preservation, and consisted of a large quantity of cypress burs, wood and bark, tropical cane, ferns, palmetto leaves, several stumps of trees, and even the greater part of a flower of the strelitzia class, which, when destroyed, was not full blown. There was no sign or indication of any very large trees, the cypresses that were discovered

being the largest that were growing here at the time. These various matters had been torn up by their roots and twisted and split into a thousand pieces, apparently by lightning, combined with a tremendous tempest or tornado; and all were involved in one common ruin. Several veins of iron pyrites ran through this stratum.

"The next over this formation was a layer of plastic clay of the Eocene region, also with iron pyrites—it was three feet in thickness. Over this was a layer of conglomerate, from nine to eighteen inches in thickness; over this a layer of marl of the Pliocene region, from three to four feet in thickness; next a second conglomerate, from nine to eighteen inches in thickness; this was succeeded by a layer of yellow clay of the Pliocene; over this a third layer of conglomerate, from nine to eighteen inches in thickness; and at last the present surface, consisting of a delta, or alluvial deposit, formed by the river, consisting of brownish clay, mingled with a few pebbles, and covered with large oak, maple and elm trees, which were, as near as I could ascertain, from 80 to 100 years old. In the center of the above-mentioned deposit was a large spring which appeared to rise from the very bowels of the earth, as it was never affected by the severest rain, nor did it become lower by the longest drought."—*Dr. Koch's Pamphlet of* 1843, pages 27, 13 and 14.

The first question before us is: Whether the observations and conclusions in the above statements may be accepted with confidence because made by a geologist, or a man of scientific training?

In the account of the second case above cited, Dr. Koch says that the Missourium was embedded in "a brown alluvium of the *Eocene* region" resting on the "upper green sand;" that next over it there was plastic clay of "the Eocene region" and beds of "the Pliocene region." He thus makes his Missourium to have come from the Lower Tertiary, and from a bed just above the upper green sand (Cretaceous), when actually from Quaternary beds; and he uses the terms *Eocene* and *Pliocene* as if he had no familiarity with geological facts or language. The earlier pamphlet of 1840 avoids this bad geology, the "upper green sand" in that being called simply quicksand, and the other beds merely beds of clay and conglomerate. All the pamphlets sustain the conclusion that Dr. Koch knew almost nothing of geology, and that what he gradually picked up from intercourse with geologists he generally made much of, but seldom was able to use rightly.

In zoölogical knowledge he was equally deficient. The account of the Missourium, in the pamphlet of 1841, recognizes a resemblance to the Mastodon and Elephant; but, notwithstanding this, it says that "his feet were webbed;" that he had "been without doubt an inhabitant of water courses such as

large rivers and lakes," as his webbed feet, solid bones without marrow, short and thick legs, flat and broad tail, etc., proved; that his curving tusks, 10 feet in length, "were carried by him almost horizontally [as represented on the cover of the pamphlet of 1843], so that it would be impossible for him to exist in a timbered country;" that his food (the teeth having before been described rightly as eight in number, "four upper and four lower") "consisted as much of vegetables as flesh, although he undoubtedly consumed a great abundance of the latter;" that he "*was capable of feeding himself with his forefoot, after the manner of the beaver or otter;*" and that he "possessed, also, like the hippopotamus, the faculty of walking on the bottom of waters and rose occasionally to take air;" that "the singular position of the tusks* has been wisely adapted by the Creator for the protection of the body from the many injuries to which it would be exposed while swimming or walking under water; that it appears that the animal was covered with the same armor as the alligator, or perhaps the megatherium."

Later in the pamphlet, he goes on with his conclusions and says: "After having examined this subject in all its bearings, I have come to the conclusion that the *leviathan*—described in the 41st chapter of the book of Job—is none other than the Missourium here described, and from this time I shall call it the *Missouri Leviathan* (*Leviathan Missourii*)."

Next follows a comparison with the account of Job, taking up the several verses in order. On the first, "Canst thou draw out Leviathan with a hook?" he says: "The Missourium, as I have described, was a creature of enormous magnitude, ferocity, and strength, as well as fleetness in swimming; and by reason of his great weight and strength could attack the largest animals with impunity and overcome them with ease; nor is it probable that any combination of human force was able to draw him out of his native element." The sentence "Who can come to him with his double bridle?" has the following exposition: "The tusks coming out of the head until they arrive at a parallel with the nose, then turning suddenly back and forming a semicircle around the head (like a shield to prevent anything from approaching it), and measuring from point to point in a straight line over the head 15 feet; it can be seen at once how utterly futile would be any attempt to cast a bridle over him."

Dr. Koch closes this exposition and his pamphlet with a paragraph explaining how the "Leviathan, which is described as being an inhabitant of Asia, came to be found in the extreme west of the globe."

* The position which one chanced to be in when the Missourium was exhumed, In the newspaper article by Mr. Koch, cited in this Journal at p. 191 of vol. xxxvii, a *Mastodon* is reported as having been found with the tusk in this position, and "Koch's Missourium" is mentioned as a nondescript animal, the head of which he found near the same place.

The Dublin pamphlet of 1843 shows some gain in knowledge; but the author still holds that the Missourium was not solely herbivorous; that its tusks curved outward horizontally; that it "waded frequently at the bottoms of the former gigantic rivers and lakes of the west;" that "the ribs resembled more those of the Reptilia than those of the quadrupeds, being situated half reversed in the body [Dr. Koch's misplacement of them]; that is, the lower edge of the rib bends in toward the intestines, and the upper edge out toward the skin" (as stated *also* in the pamphlet of 1840); and he ends off with the same detailed "comparison of the Leviathan with the Missourium," and the same explanation of how such an Asiatic inhabitant came to be found "in the extreme west of the globe."

Now this web-footed aquatic animal, capable of feeding himself with his forefoot, was no other than the *American Mastodon*, whose forefeet were as good for putting food into its mouth, or picking its teeth, as any Elephant's. The specimen taken to England, in 1841, as the Missourium, and which Professor Owen says was "well-known to the public as the *Missouri Leviathan*, when exhibited with a most grotesquely distorted and exaggerated collection of the bones in 1842 and 1843 in the Egyptian Hall, Piccadilly," is now (1846), he adds,* an almost complete skeleton of "the *Mastodon giganteus*, mounted in strict accordance with its natural proportions in the British Museum;" and a representation of it, copied from Owen, is the figure of the Mastodon on page 566 of the writer's Manual of Geology.

It is pretty plain that Dr. Koch had not been trained to scientific investigation. This is equally obvious from his two pamphlets on the "Hydrargos."

(1) The skeleton exhibited in New York in 1845, and described in the pamphlet of that date, was 114 feet long, and this was at least 35 feet longer than nature—the vertebræ gathered by him in Alabama having been all strung together into one long "Hydrargos," though belonging really, as Dr. Jeffries Wyman announced, to individuals of different ages, and according to Müller, to at least two species (*Zeuglodon macrospondylus* and *Z. brachyspondylus* of Müller).

(2) The head was in part a piece of bad patchwork; Dr. Wyman stating in his notes, made after a careful examination,† that the cranium proper (the part over the brain) was made out of a single piece of bone without sutures, leading to the supposition that it was not the true cranium, an inference sustained, he says, by there being no foramen for the passage of the spinal

* History of British Fossil Mammals and Birds, by Richard Owen, F.R.S., etc., London, 1846, page 298.

† Proceedings Boston Nat. Hist. Soc., 1845, p. 65. In this Journal, II, ii, 129 (1846), where Dr. Wyman's article is noticed by B. Silliman, Jr., there is a figure of the remarkable head.

marrow, and no larger space for the brain than that for the spinal cord on the upper side of some of the vertebræ; and by the amount of cement, which left little or nothing of the under surface in sight.

(3) The extremities of the so-called paddles were formed, says Dr. Wyman, of *casts of "a species of Nautilus."*

The Hydrargos or Hydrachen pamphlets hence do not require any modification of the opinion that Dr. Koch had not been trained to scientific investigation.

But on this point we have the opposing assertion of Dr. Koch. Being in a foreign country, where he had to make himself known, he opens his pamphlet of 1843 with the following introduction of himself to the public:

"Previous to my commencing this Treatise, I wish particularly to mention that I have not only devoted the greater part of my life to the theoretical study of Natural History, but have also made myself intimately acquainted with the practical part of it."

Still, we are unable to set aside the facts presented in the preceding pages and the opinion to which they have led, and therefore feel forced to take this introductory paragraph differently from what the author intended, and gather from it that Dr. Koch was a man of large pretensions. This same impression is conveyed by the account of his scientific travels in North America, which occupies the following six pages. I give an example. On the third of these pages he describes the era of the "mighty Missourium" and "ponderous Mastodon" as a time when, according to "every geological research," the earth's surface was "uninterrupted by any of the rough, broken, rugged deformities which now present themselves on every side," when "the climate was free from noxious vapors," and all was "delightful," etc.; and then dwells on the sudden dreadful change when "the ground was cursed for man's sake" and "all those gigantic creatures perished," and "the garden of delicious fruit trees and blooming flowers was converted into a gloomy forest of thorns and thistles." He also gives us his idea as to the nature of the great catastrophe, as follows: "The principal instrument used to cause this change, according to my views, was a certain Comet that came in contact with our globe, which caused not only a different position of our earth, but also the interior fire and water to come into an immediate violent collision, which created a revolution, that naturally sought for vent, and therefore burst through the crust of the quivering earth, tore up countries and sank them in the sea."

This is enough to prove that these pages do not sustain his large claim.

Holding, then, to the conclusion that Dr. Koch was quite

ignorant of geology and without scientific training, we are forced to doubt, to doubt strongly, his direct and definite statement that he had devoted the greater part of his life to "the theoretical study of Natural History" and had made himself "intimately acquainted with the practical part of it." It is true that he knew about the earlier part of his own life better than any other person then living. Any way, he certainly overrated almost infinitely the results on himself of so prolonged study. This much we are disposed to allow in favor of his sagacity: that Dr. Koch appreciated the absurdity of the Leviathan story, and introduced it, after some thought about the people he was among, merely to get a full house for his Missourium; and that his attempted show of scientific knowledge had the same end in view. If this supposition is unjust to him, the other alternative explanation has to stand. In his New Orleans "Hydrachen" pamphlet (1853), the inside pages of the cover contain a long cited article* which makes the Zeuglodon the Leviathan of Job—thus showing apparently that his previous convictions were not too strong for a change of opinion, especially after the Missourium had turned into a Mastodon.

The special statements respecting the mode of occurrence of the human relics cited on pages 338 to 340 remain for consideration.

In the account of the deposits which afforded the Missourium, Dr. Koch speaks of "the present surface as consisting of a delta or alluvial deposit," which suggests a doubt as to whether the overlying beds of sand and pebbles may not have been of very recent formation through river action. It is not made certain that they were true Champlain deposits. He says that one arrow-head lay "immediately under the femur or thigh-bone," and he further states, in his later article of 1857, that he "carefully thought to investigate" the point as to its having "been brought thither after the deposit of the bone," and decided against it. The observation and conclusion would have been more satisfactory had the author of them been a better observer.

The description of the deposits in Gasconade County, containing the remains of an animal "the principal part of which had been consumed by fire," is a still more unsatisfactory basis for a safe conclusion as to age. But in the article of 1857 he says that "the layer of ashes, etc., was covered by strata of alluvial deposits consisting of clay, sand and soil from eight to nine feet thick *forming the bottom of the Bourbeuse [River] in*

* It is headed "From the New York Evangelist," and must have been written in 1845, when the skeleton was on exhibition in New York City. The author's name is not given.

general," which seems to make it almost certain that the beds were of quite recent origin. Neither in the account of 1839, nor of 1843, is the kind of animal mentioned, that of 1843 saying that "they were the remains of an animal which had clawed feet and was of the size of an elephant," and "that the construction of the foot [fore foot] shows that it possessed much power in grasping and holding objects;" but in that of 1857 he says "the bones were sufficiently well preserved to enable one to decide positively that they belong to the *Mastodon giganteus*."

The tragic part of the story—about the elephantine beast having been burnt alive by the Indians after they had used their bows, and also thrown more than 150 great pieces of rocks "two to twenty-five pounds in weight" at him in vain,—is an hypothesis in keeping with the rest of his documents. A fire kindled about the shoulders of a mired Mastodon would have taken long to get through the hide and muscle so as to char the bones; and an Indian's appetite would have been pretty sure to have stopped the cooking short of this charring. The charring might have been done very long after the miring and death of the animal, and the facts be all as they are reported. The remark that "the greater portion of the bones had been more or less burned by fire" favors the idea that the fire was made about the bones at some time between the era of the Mastodon and the present time, and not about the living body.

The failure to repeat, in either of the later accounts, the early statements respecting the large pieces of skin that appeared like fresh tanned sole-leather," and the "sinews and arteries plain to be seen on the earth and rocks," shows that he afterward doubted and rejected this part of his observations; and this unavoidably suggests some doubt as to the other points; even to questioning whether the charring was not in fact only a blackening in color due to burial in the marsh—a very common effect from such a cause; whether the crumbling was not a result of that natural decay which so generally befalls old bones; and whether the stone implements found were not small oblong stones of nature's chipping or polishing.

Thus stands the evidence. If the statements respecting the deposits had been published by a good geologist with no more of detail, and without any special effort afterward to make all things positive, there would be some room for doubt, considering the many chances of error that exist. But in the present case they were not made by a good geologist; they were not made by one trained to investigation, or to habits of precise statement; nor by one who had a knowledge of any department of science; nor by one whose sound common sense was so obvious a characteristic as to demand consideration for his

opinions and statements; nor by one wholly free from pretense and sham.

Taking all things that have been reviewed into consideration, I think there is sufficient reason for regarding Dr. Koch's evidence of the cotemporaneity of Man and the Mastodon *very doubtful.* It is to be hoped that the geologists of the Missouri Geological Survey now in progress will succeed in settling the question positively.

The cotemporaneity claimed will probably be shown to be true for North America by future discoveries if not already so established; for Man existed in Europe long before the extinction of the American Mastodon.

Art. XXXVI.—*Bentham, On the recent Progress and present State of Systematic Botany.*

[Continued from page 294.]

As to the necessity or advantage of artificial keys to species in systematic works, when the species of a genus are brought into an order which as much as possible exhibits their natural relationships, it is seldom difficult to divide and subdivide the groups by important characters, if pains enough be taken, so that the series of subordinated divisions shall completely and practically do the work of an artificial key. The advantages are that the student's attention is fixed from the first upon the more natural characters and their combinations; also, the more thorough the subdivision, the briefer and more diagnostic may be the description of the species, since the points mentioned in the sections need not be repeated.

In this connexion we can best bring in the few remarks we have to offer upon the present tendency, which Mr. Bentham favors, to merge specific character (or full diagnosis) and detailed description into one, making of that one the latter rather than the former, and drawing it up, when Latin is used, in the nominative rather than in the ablative case. Granted that "we cannot now restrict them to the twelve-word law of Linnæus," and that "a twelve-line ablative diagnosis is an absolute nuisance," our choice is not bound to either of these extremes, and the happy medium may generally be hit. The diagnostic form is a constant enjoinder of brevity and of utmost perspicuity. The protracted specific characters which Mr. Bentham rightly deprecates generally mean slovenly work. To keep them within bounds we have only to insist upon critical grouping, and subordinated sections and subsections, such as we have just recommended. In this way we adapt the Linnæan diagnosis to our

present needs, retaining all its advantages. The other course we fear will tend to prolixity and looseness, however well it may work in such judicious and practised hands as those of Mr. Bentham. Finally, if we have no diagnosis, but only a description, then the nominative case is a matter of course. If we retain the Latin diagnosis, we may well retain the ablative case, as having some advantage in succinctness, and the *prestige* of long use. A reasonable punctuation ought, however, to be settled on,—the two prevalent extremes being about equally awkward and inconvenient. A *juste milieu* is not far to seek. Even in English there is still advantage in the diagnostic form, relegating details and subsidiary or explanatory matter to a separate sentence or paragraph.

Of Linnæus's two great gifts, the binomial nomenclature and the diagnosis, we are almost as reluctant to give up the one as the other.

Upon the languages actually in use in systematic botany, Mr. Bentham has some interesting remarks, which fill three or four pages. In the preparation of this and his previous somewhat similar addresses, he had to consult botanical publications in no less than fifteen languages. Surely no other living botanist is able to do so, and to read a majority of them with facility. It is conceded that, while works intended for the beginner or amateur, or for teaching the well-known botany of a particular country, should be in the familiar language of the country, yet "purely scientific treatises, and technically descriptive works, which all botanists may have to take cognizance of, and for which the commercial demand may be too limited to ensure their translation into various languages," should be written in the one most likely to be understood by the greater number of students of all countries,—that is, in Latin; which, moreover, is "best suited for technical diagnoses and descriptions, from its concise character and from its susceptibility of being subjected to technical forms, without jarring upon the conventionalities of living languages in familiar use." To which we may add, that a sufficient, long-tried, and well-settled vocabulary has been formed from it, which cannot be readily rendered into other tongues without danger of ambiguity, except by transferring the terms themselves, as we have done, into English, the genius of our language lending itself readily to the transference. Happily, botanical English and botanical Latin are very much alike.

Modern languages are, and must needs be, more and more used for general descriptions and scientific investigations and discussions; "and of these are three which at the present day every botanist ought to understand, and in one of which [besides his vernacular] he ought to be able to write,—all three

having a rich literature in every branch to repay the labor of learning them, independently of science; these are French, English, and German."

"French has long been considered the one among modern languages forming the nearest approach to a common one; it is easy, comparatively simple in construction, not overburdened with redundant words, and, above all, is readily broken up into short phrases, an invaluable qualification for clearness of methodical exposition. It has long been the recognized diplomatic language, and the first foreign one taught in most European schools; and although within my own recollection national animosities may have from time to time thrown it into disfavour in Germany and Eastern Europe, yet it always appears to recover its *prestige* there in general society. At the meetings of the botanists of various nations congregated at Florence last May, it was the general medium of intercourse, although the Frenchmen present were in a very small minority. And in every branch of science or literature to which I have paid more or less attention, it possesses more instructive elementary works, more readily intelligible treatises and clearer expositions of abstruse subjects, than any other language I am acquainted with. For the botanist, therefore, as well as for all naturalists, its study is still, and I believe will long remain, of first-rate importance.

"The English language has of late years been recommended by more than one continental naturalist for general adoption as a vehicle for international scientific intercourse. It partakes of some of the advantages of both the French and the German. Though less brilliant, it offers more variety than the former, it is less involved than the latter, and it appears to be capable of giving more precision and force to argument than either. It is now the national language of the largest proportion of the civilized population of the globe, and its use continues steadily to spread out of Europe generally, and to a certain extent among European naturalists and other educated classes, especially in eastern and northern Europe. They begin to admit the necessity of consulting our untranslated treatises and memoirs, and our German and east European botanical correspondents, at least, accept English letters as readily as French. In southern Europe French is still much more generally understood; but even there the objections to the extended use of our language for botanical works have now, I believe, lost much of their force.

"The German is a more difficult language, much more difficult, indeed, for the Latin nations of southern and western Europe than for ourselves. Its construction is involved, its extraordinary copiousness occasions a strain upon the memory; but it affords great facilities for giving expression to minutely dis-

tinguished details, whether of fact or of thought. It may thus frequently give greater solidity to their theoretical expositions than the French, but is infinitely more difficult to translate; and to those who are not thoroughly used to its intricacies it seems to foster, if not to create, confusion of ideas. Germany has now, however, so long included so many publishing centres of scientific importance, and its language has been so generally used by Scandinavian and Sclavonian, as well as by their own naturalists, that a sufficient acquaintance with it, to study the very numerous works it produces, can no longer be dispensed with by the general botanist."

Mr. Bentham goes on to consider the principal classes of works in systematic botany, recently published or in progress, under the heads: 1. of *Ordines Plantarum*, or the like,—of which Lindley's Vegetable Kingdom (very great in its merits and its faults) was the most complete and elaborate, and Le Maout and Decaisne's *Traité de Botanique* (and especially Dr. Hooker's English edition) the only modern substitute, and indeed far better in the way of structural exposition. But it covers less ground. Mr. Bentham rightly enough deprecates the proposed reproduction of Lindley's great work, as "scarcely fair to the memory of the talented author." To the bizarre classification and many strange and fanciful views of affinity not even Lindley's talents and ardor could give vitality and currency during his life-time. But there is a part of this thesaurus which might be reproduced, with needful additions, to great advantage, namely that which relates to the properties and uses of plants. This, well edited, would form a good-sized and surely a most useful volume,—a companion and supplement to the French work just mentioned, which is weak in this department.

Under the second head, of *Genera Plantarum*, a good account is given of the scope and plan of the work upon which Mr. Bentham is now engaged, in conjunction with Dr. Hooker. This publication began in 1862, and is now, it may be said, half done. We may count upon having the second volume completed before the present year is out

Under the third head, of *Species Plantarum*, after more remarks upon De Candolle's Prodomus, and its completion, or rather its close at the end of the Dicotyledons, Mr. Bentham raises the question whether it may not still be practicable to have a condensed Species or Synopsis Plantarum for all Phænogamous plants, within a single generation. Alphonse De Candolle's recent estimate and hopeless conclusion are familiar to us. Mr. Bentham's less discouraging view, the grounds of which are disclosed in the following extract, is largely based upon his own experience.

"Alphonse De Candolle, in the above-quoted 'Reflexions,' has shown how little chance there is of a uniform 'Species Plantarum' being again undertaken with any prospect of its being brought to a successful conclusion. He calculates that it would require fifteen or sixteen years' labour of some five-and-twenty botanists, working under the direction of about eight to ten editors,—a combination which it is highly improbable will ever be practically brought to bear. His calculations may, however, be a little overcharged. He supposes that each botanist would not work up more than 300 species in a year: that may be the case in a monograph, when every detail is to be gone through from personal observation; but this would not now be necessary in a general 'Species Plantarum,' which would be most useful as a concise methodical compilation. Much of the labour expended on the 'Prodromus' and on detached monographs and floras need not be repeated. As pre-Linnæan synonyms, upon which so much time was formerly expended, have now been generally given up, so, for post-Linnæan synonyms, there would now be no use in repeating those given in the 'Prodromus' and other works compiled from, unless where errors have been detected; and this alone would save a great deal of time, labour and expense. And with regard to the greater number of the orders or genera contained in the recent volumes of the 'Prodromus' and the best modern monographs and floras, a careful and intelligent abridgment of the specific characters without reëxamination is all that would be necessary.

"It might be useful to consider what would be the requisites of any such abridged 'Species Plantarum' or 'Synopsis,' restricted within limits which should render it possible, at least as to phænogamous plants. We might expect it to follow the sequence of orders the most generally adopted, that of the 'Prodromus' and of our 'Genera Plantarum,' with such slight modifications only as the progress of science has rendered necessary, without attempting hypothetical improvements. To each order and to each genus should be given short diagnostic characters, abridged from the last 'Genera Plantarum' or other best sources, selecting chiefly those which are most essential and contrasted, but including also the most striking or the most general amongst the adaptive ones, and a general indication of geographical range, with careful reference to the works where more details are to be found. Where the orders or genera are large, a synopsis or conspectus of the principal divisions and subdivisions would be useful.

"To each species should be given:—

"(1) The name.

"(2) The diagnosis, specific character, or abridged descrip-

tion, which are but different names for the same thing, and which it appears to me would be always more satisfactory in the nominative than in the ablative case. After the example of Linnæus, and based upon the doctrine of the fixity of species, it has been almost universally the custom to distinguish the specific diagnosis and description, the former to contain the absolutely distinctive characters (any deviation from which would exclude a plant from the species), the latter to aid the student in identifying a plant by the enumeration of characters which, though general, might vary in the same species, or which it may possess in common with other species. In order to mark the more strongly this difference, the diagnosis, when in Latin, has been given in the form of the ablative absolute, the description in the ordinary nominative form. There is, however, nothing really absolute in nature. There is no class of characters which may not occasionally admit of exceptions: and although care should be taken to select the most important and constant ones, yet in some instances, those which are generally discarded as too variable for a diagnosis, such as dimensions, colour, &c., may yet be most useful, or even essential for the distinction of species, or even of genera. These diagnoses, moreover, to be useful should be short. We cannot now restrict them to the twelve-word law of Linnæus, but a twelve-line ablative diagnosis is an absolute nuisance.

"(3) Reference to the source whence the diagnosis is taken, to the work where a further description, the synonymy, and history of the species are to be found, and to any plates where it may be satisfactorily represented; and all further synonymy should be avoided, except where it may be necessary to refer to descriptions, names, or modifications published since the one specially abstracted from.

"(4) The habitat of the species.

"(5) Occasional notes on affinities or other points in the history of the species should be very sparingly indulged in, and only when they may assist essentially in the provisional determination and elucidation of a plant. All discussions on doubtful points and all details should be reserved for monographs or separate papers, where alone they can really tend to the advancement of the science.

"Each volume of the 'Synopsis' would of course be accompanied by a full index of genera, species, and such synonyms as it may have been found necessary to give.

"The whole work would be so indispensable to botanists of all nations, that, like the 'Genera Plantarum,' it should be entirely in botanical Latin, which, moreover, from the number of conventional expressions to which a technical meaning has been assigned, is specially suited for short diagnoses.

"No new species should be first published in this 'Synopsis.' Nothing has tended more to produce confusion in systematic botany than the publication of real or supposed new species, with short diagnoses, unattended by any full description or detailed indications of its affinities, &c. However carefully the diagnosis may be worded so as to distinguish the species from those previously published, it would be insufficient for its identification, and full descriptions would be inadmissible from the plan of the work. At the same time, it is to be expected that the author, in preparing the 'Synopsis,' should meet with new forms, which he may be desirous to make known, in order to render his work as complete as possible. But his course should be to give their full history in a separate monograph, to which, *when published*, he could refer in the 'Synopsis.' He should here not only thus avoid all addition to the numerous puzzles with which the science is overloaded from insufficient description, but strictly abstain from all mention of manuscript and other names which, according to the recognized rules of nomenclature, are not admitted as sufficiently published.

"The grade of plant-race to which the specific name and diagnosis should be attached would be the species, in the Linnæan sense, which, though not susceptible of a strict definition, is pretty generally understood amongst botanists, whether they may designate it as a true species, a Linnæan, or a compound species The 'Synopsis' might also distinguish marked varieties whose admission or rejection as species might be doubtful; but the innumerable forms variously termed varieties, subspecies, or critical species, should be passed over in silence, as their admission would simply render a general work impossible, and a more partial one comparatively useless. The enumeration and distinction of the various forms of *Brassica campestris* and *oleracea*, of *Pisum sativum*, *Viola tricolor*, &c., may be serviceable to the agriculturist or gardener, that of the forms of *Rubus fruticosus* may be interesting to the investigator of the flora of a limited district, but they are only useless encumbrances to the general systematist as well as to the naturalist in other branches who would have to make use of the 'Synopsis;' and the names and diagnoses of two hundred forms of *Draba verna* would be a simple nuisance, of no use whatever to any one.*

* "The mode of dealing with species which, in the present state of vegetation, pass into each other through a series of intermediate forms which cannot fairly be supposed to be hybrids, is well discussed by Nägeli in a series of papers in the "Sitzungsberichte" of the Munich Academy for 1866, the result of careful observation chiefly of the genus *Hieracium*. After admitting himself to have been originally a firm believer in the fixity of species and a strong advocate of the hybrid parentage of the large number of intermediate forms observed, he acknowledges his conversion to the doctrine of evolution. "In the present state of the science" he sees "no other possibility than the assumption that the species of *Hieracium* have

"Taking the species, therefore, in the Linnæan sense, we would, with Alph. de Candolle, estimate the number of Phænogams now published, or in the course of publication, from materials already in our herbaria, at between 110,000 and 120,000. A competent botanist would readily get through three or four thousand in a year. In the 'Flora Australiensis' I had no difficulty in preparing a thousand to twelve hundred in the year, and that was all original work, entailing the personal examination of every species often in numerous specimens, and a long and tedious investigation of synonyms. Such a compilation as I have above characterized would require, it is true, a competent knowledge of plants and occasional verifications; but still the labour would be reduced by at least two-thirds; and 300 species a month, with a month or six weeks' vacation, would be no great strain upon the mind. Thus three or four botanists might complete a synopsis of ten thousand species in the year; and the general synoptical enumeration of all known Phænogams would not be beyond the range of possibility, however little chance there may be of my living to see it commenced."

The doubt which rises is, whether several or indeed any botanists can be found in our day capable of turning off good work at anything like Mr. Bentham's rate, and so exceptionably well situated in respect to herbaria and libraries, and in the command of their time. Easy as the work may seem, the number of botanists who are able to elaborate a genus and draw up fairly good botanical descriptions is wonderfully small.

arisen by transmutation either from extinct or from still surviving forms, and that there are still persistent a great number of the intermediate stages (races) formed either by the original differentiation of the extinct species, or in the course of the transformation of one yet living species into the diverging forms."—*Sitzungsber.*, 1866, i, 330.

In a subsequent paper he shows that the genus *Hieracium* affords instances of great diversity in the degree to which differentiation has attained and in the definiteness of the species established by the extinction of intermediates. He instances, amongst those to which he would in their present state assign the rank of species:—

1. Aggregate forms, such as *H. Pilosella*, which cannot as yet be separated into distinct groups. *H. Hoppeanum*, Schult., *H. Pelleterianum*, Mérat, *H. Pseudo-pilosella*, Jen., are not yet sufficiently isolated by the disappearance of intermediate forms to be ranked as species.

2. Forms which, by the disappearance of closely allied ones, have attained sharper and more fixed limits, and yet between which isolated intermediates may still be found, are exemplified by *H. Auricula*, *H. aurantiacum* and *H. Pilosella*, or by *H. murorum*, *H. villosum* and *H. glaucum*. On the other hand, it is uncertain whether the relations of *H. Auricula* and *H. glaciale*, or of *H. murorum* and *H. vulgatum*, should be included in this stage, or are still in the first-mentioned category.

3. Species between which no constant intermediates survive, but which still are capable of producing intermediate hybrids, are represented by *H. alpinum* and *H. villosum*, by *H. alpinum* and *H. glaucum*, by *H. murorum* and *H. umbellatum*, &c.

4. Lastly, the three sections *Pilosella*, *Archieracium* and *Stenotheca* are races which become so far-distanced from each other that hybrid fertilization no longer takes place between them.—*Sitzungsb.*, 1866, i. 472.

The thing is quite possible if mere literary compilation is intended; but something more than this is needed.

While it would be best, and in case of a mere compilation even necessary, that new species should be first published elsewhere than in this desired "Synopsis," yet we cannot agree that, in any proper elaboration or digest of the species of a genus, "the diagnosis would be insufficient for its identification." It is just here, where the new species is brought into line with its relatives, that the diagnosis should suffice: and if a diagnosis does not serve for the new species, it may do no better for the old ones. Upon the form in which specific characters may best be cast, in a synoptical work—whether that of diagnoses, under sections and subdivisions, or of open descriptions, led to by an artificial key—we have already offered some remarks.

Mr. Bentham proceeds to discourse of monographs of orders and genera, of floras or histories of the plants of particular countries or districts (this division ending with a loud call for the North American Flora), and, finally, of specific descriptions, detached or miscellaneous. His remarks upon the latter are important and timely.

"Had I to report only on the progress, and not on the present state also, of systematic botany, I should here stop; for the great majority of recent detached and miscellaneous descriptions are almost as much impediments as aids to the progress of the science. I have too often in my Linnean Addresses, especially in those of 1862 and 1871, animadverted on the mischief they produce, to enter now into any details; I can only lament that the practice continues, and is even rendered necessary by considerations not wholly scientific. Horticulturists must have names for their new importations. It is due to travellers who, under great perils and fatigues, have contributed largely to supplying us with specimens of the vegetation of distant regions, that the results of their labour should be speedily made known; it is even important to science that any new form influencing materially methodical arrangements should be published as soon as ascertained. But all this is very different from the barren diagnoses of garden-catalogues, and the long, uncontrasted descriptions hastily got up for the futile purpose of securing priority of name. I own that I have myself erred in the want of sufficient consideration in the publication of some of the species of Plantæ Hartwegianæ; and some descriptive miscellanea, even by men who stand very high in the science (such as Miquel's 'Prolusiones,' above referred to, and Baron von Mueller's 'Fragmenta'), are rendered comparatively useless from their utter want of method. Whilst, therefore, discouraging as much as possible all such detached publications of new species, I would admit their occasional necessity, but suggest the following rules as the result of a long practical experience:—

"No detached description of a new species should be ventured upon unless the author has ample means of reviewing the group it belongs to; and if any doubts remain of its substantive validity, he should refrain from giving it a name till those doubts are cleared up.

"The description, when given, should be full, but contrasted and accompanied by a discussion of affinities with previously known species, and an indication of the place the new one should occupy in the several monographs and floras in which it would be included.

"An illustration of the new plant, with analytical details, should never be neglected where circumstances admit of it."

We would heartily second these recommendations. They are especially applicable in this country. Time is short and the work before us is heavy. One grievous impediment to its progress and trial to patience comes from the loose and rambling descriptions of species, or even genera, hastily put forth by those who have not the means of making the proper investigations and comparisons, and in some cases not the knowledge which enables them to hit the genus or even the family correctly. The best of us commit mistakes enough, but, it is to be hoped, clear up many more than we make. The road we have to traverse, and to make smooth for those who come after us, is difficult and rugged enough as it is. Shooting rubbish into it is a serious hindrance. Real aid, however, is joyfully welcomed, and no one in our day who is able, or desirous even to attempt to do systematic botanical work, has ever received aught but help and encouragement from those who have to bear the burden and heat of the day. A. GRAY.

ART. XXXVII.—*On the Influence of Color upon Reduction of Light;* by M. CAREY LEA.

IN this Journal for March of last year, I published a train of investigations which had for their object the study of the changes produced in the sensitiveness of certain substances to particular rays of light, as caused by the presence of various colored and uncolored bodies. These results were incompatible with a law shortly before announced by Dr. Hermann Vogel, as governing the action of colored bodies on the sensitiveness of silver bromide.

Dr. Vogel's law was, that to render AgBr sensitive to any ray, or to increase its sensitiveness, it is only necessary to place in contact with it a substance capable of promoting the decom-

position of AgBr, and which substance must absorb the rays in question, and not other rays.*

My own conclusion was that the power of heightening sensitiveness to particular rays was one in no way connected with the color of the sensitizing body; indeed, that perfectly colorless bodies, or bodies having very pale neutral colors might also exercise the functions of heightening sensitiveness to particular colored rays.

Since the publication of my former paper, I have made further investigations, and Dr. Vogel has published a second paper. In this second paper Dr. Vogel, from whom I have regretted to differ, has to a considerable extent adopted my own views. He reaches the same conclusion, as to the power of substances destitute of color to exalt the sensitiveness of AgBr to particular rays. As this was the main result of a long investigation, and the demonstration of it the principal object of my paper (from which paper and its conclusions Dr. Vogel strongly dissented), it would have been more agreeable to me if Dr. Vogel had acknowledged it as originating with me. This, however, is a matter of small importance. Dr. Vogel does not seem to have adverted to the fact that this conclusion is scarcely compatible with his theory, formulated in the foot-note; with the alleged function of *color* as modifying sensitiveness to particular rays.

If this theory were true, it must be easy to find very numerous instances capable of supporting it, as the number of organic coloring matters capable of taking up bromine is very large. Nevertheless, three only have been brought forward by Dr. Vogel in the two papers referred to, out of which three, two at least certainly do not seem to afford the desired proof.

Coralline and naphthaline red are substances which transmit strong red light, and consequently the sum of their absorption spectra must in each case be green: to confirm Dr. Vogel's theory, they should enhance the sensitiveness of AgBr to green light. But Dr. Vogel finds an increased sensibility to *yellow* rays only. Obviously yellow cannot represent the absorption by a red color. If Dr. Vogel's law be true, a red substance *may* heighten sensitiveness to yellow, but it *must* heighten it to green.

Now with the substance principally experimented on by Dr. Vogel, coralline, I have lately made a number of trials, and have succeeded in definitely fixing its action with respect to AgBr.

* Wir im Stande sind Bromsilber für jede beliebige Farbe lichtempfindlich zu machen, respectiv die bereits vorhandene Empfindlichkeit für gewisse Farbe zu steigern; es ist nur nöthig einen die chemische Zersetzbarkeit des Bromsilbers befördernde Stoffe zuzusetzen, welcher die betreffenden Farbe absorbirt, die andern nicht.—*Ber. Deutsch. Chem. Ges.*, 1873, p. 1305.

To the red rays, including those whose wave-lengths are from λ605 to the end of the visible spectrum, coralline very materially increases the sensitiveness of AgBr.

To the yellow rays, taking as representatives those whose wave-lengths vary only moderately from λ570, coralline moderately increases the sensitiveness of AgBr.

To the green rays, taking principally those whose wave-lengths lie between 517 and 569, coralline gives *no increase whatever* of sensitiveness to AgBr.

So that coralline, far from being a support to the theory of Dr. Vogel, gives in fact a confirmation of my own view, viz: that substances heighten the sensitiveness of AgBr to particular rays, without the existence of any relation between the color of that ray and their own proper color.

It is a little curious that coralline acts very differently with AgI. So far from increasing the sensitiveness of that substance to red light, it actually diminishes it.

Rosaniline is another substance whose action conflicts with Dr. Vogel's law. I find that it quite destroys the sensitiveness of AgBr to yellow rays.

From all the foregoing I conclude, that there exists no relation whatever between the color of substances and the color of the ray to whose influence they modify the sensitiveness of silver bromide.

Philadelphia, March 20, 1875.

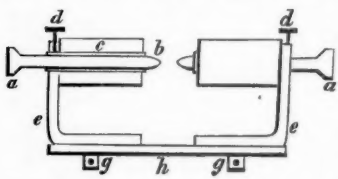
ART. XXXVIII.—*On a New Diamagnetic Attachment to the Lantern, with a Note on the Theory of the Oscillations of Inductively Magnetized Bodies;* by HENRY A. ROWLAND, Assistant Professor of Physics in the Rensselaer Polytechnic Institute.

1. *Description of Apparatus.*

SOME time ago, in thinking of the theory of diamagnetism, I came to the conclusion that apparatus of large size was by no means necessary in diamagnetic experiments, and on testing my conjectures experimentally, I was much pleased to find that they were true. So that for more than a year I have been in the habit of illustrating this subject to my classes by means of a small apparatus weighing only about a pound or two, which I place in my lantern and magnify to a large size on the screen.

The effects obtained in this way are very fine and are not surpassed by those with the largest magnets; and we are by no means confined to strongly diamagnetic substances, but, with proper care, can use anything, even the most feeble. The appa-

ratus which I used consisted of a horseshoe electro-magnet, made of an iron bar half an inch in diameter and about ten inches long, bent into the proper form, and surrounded with four or five layers of No. 16 wire. But the following apparatus will, without doubt, be found much more convenient. It can be made of any size, though the dimensions given will probably be found convenient.



The apparatus is represented in fig. 1. To a straight bar of iron h, 7 in. long, $\frac{1}{2}$ in. thick, and $\frac{3}{4}$ in. wide, are attached two pieces e e of the same kind of iron by two set screws g g, which move in slots in the piece h. Into these pieces are screwed two tubes c made of iron and having an internal diameter of about $\frac{7}{16}$ in. and a thickness not to exceed $\frac{1}{16}$ in. Through these tubes the iron rods a b slide and are held at any point by the screws d. One end b of this rod is rounded off for diamagnetic experiments and the other enlarged and flattened at the end for magne-crystallic experiments. On the tube c a helix of No. 16 or No. 18 wire is wound so as to make up a thickness of .4 or .5 of an inch and having a length of $2\frac{1}{4}$ in. The object of the screws g is principally to allow the rods a b to be reversed quickly and to adjust the position of the helices. When the apparatus is to be used for only one kind of work it can be much simplified by doing away with many of the moving parts.

This instrument can be used either with the ordinary magic lantern, or better, with one having a vertical attachment. In the latter case the plane of the instrument is horizontal and the substances are suspended from a wire made quite small, so as not to cut off too much light.

The suspending thread in the case of bismuth can be quite large but for other bodies a single fiber of silk is best: these in the shape of bars half an inch long can be each attached to a fiber having a little wire hook at its upper end and hung in a cabinet until required.

The theory of feebly magnetic or diamagnetic bodies oscillating in a magnetic field is very simple and yet the results are of the greatest interest, especially the effect of the size of the apparatus, which is here given for the first time.

2. *Theory.*

Let a very small particle of a body whose coefficient of magnetization κ is very small, and either positive or negative, be placed in a magnetic field of intensity R; it will then have an induced magnetic moment of κvR, where v is the volume of the ele-

ment. The force acting on this particle to cause it to go in any given direction will be equal to the product of the magnetic moment into the rate of variation of R in that direction,* and hence is $\varkappa v \mathrm{R} \frac{d\mathrm{R}}{dx}$ in the direction of x. The total force acting on the body in the direction of x is therefore

$$\mathrm{X} = \tfrac{1}{2} \iiint \varkappa \frac{d(\mathrm{R}^2)}{dx}\, dxdydz,$$

and the other components of the force are

$$\mathrm{Y} = \tfrac{1}{2} \iiint \varkappa \frac{d(\mathrm{R}^2)}{dy}\, dxdydz$$

and

$$\mathrm{Z} = \tfrac{1}{2} \iiint \varkappa \frac{d(\mathrm{R}^2)}{dz}\, dxdydz.$$

Let, now, the axis of z be vertical, the axis of x in the line of the magnetic poles of the magnet, and y at right angles to both. Then the moment of the forces acting on the body to turn it about the axis of z is

$$\mathrm{M} = \tfrac{1}{2} \iiint \left(\varkappa \frac{d(\mathrm{R}^2)}{dx}\, y - \varkappa \frac{d(\mathrm{R}^2)}{dy}\, x \right) dxdydz,$$

where the integration extends throughout the volume of the body.

If the body is suspended so as to turn freely about the axis of z it will vibrate about the position for which M is a minimum or else will remain at rest at that point. The number of single oscillations made when the angular elongation ϑ is very small, is

$$n = \frac{1}{\pi} \sqrt{\frac{\mathrm{M}}{\vartheta \mathrm{I}}},$$

in which M and ϑ must be measured simultaneously, and I is the moment of inertia of the body.

$$\therefore \quad n = \frac{1}{\pi \sqrt{2\vartheta \mathrm{I}}} \sqrt{\iiint \varkappa \left(y \frac{d(\mathrm{R}^2)}{dx} - x \frac{d(\mathrm{R}^2)}{dy} \right) dxdydz}.$$

Now let us suppose that the whole apparatus changes size, the relation between the parts remaining constant, so that the apparatus becomes m times as great as before. Then x, y, dx, dy, and dz will increase m times and I, m^5 times. To determine the changes in $\frac{d(\mathrm{R}^2)}{dx}$ and $\frac{d(\mathrm{R}^2)}{dy}$ we make use of the theorem of Sir Wm. Thomson, that "*similar bars of different dimensions, similarly rolled, with lengths of wire proportional to the squares of their linear dimensions, and carrying equal currents, cause equal forces at points similarly situated with reference to them.*"

* Thomson, Reprint of Papers, Art. 679, Prob. vii.

But as the above only applies to equal currents, I have generalized it in the following. *In any two magnetic systems whatever, similar in all their parts and composed of any number of permanent or electro-magnets, wires carrying currents, or bodies under magnetic induction, the magnetic force at similar points of each will be the same when the following conditions are complied with;* 1*st. the magnetic materials at similar points in the two systems must be exactly the same in quality and temper;* 2*d, the permanent magnets must be magnetized to the same degree at similar points of the systems;* 3*d, the coils of the electro-magnets and other wires or bundles of wires carrying the current must have similar external dimensions in the two systems and must have the product of the current by the number of wires passing through similar sections of the two systems proportional to the linear dimensions of the systems.*

This will apply to the case we are considering when the product of the current by the number of turns of wire varies in direct proportion to the size of the apparatus. Hence in this case $\frac{d(R^2)}{dx}$ and $\frac{d(R^2)}{dy}$ will vary inversely as n. Hence we see that n will be inversely proportional to the size of the apparatus: and although we have only proved this for the case when κ is small, it is easy to see that it is perfectly general. The advantage of small diamagnetic apparatus is thus apparent, for the smaller we make it the more vibrations the bar will make in a given time and the more promptly will the results be shown.

It might be thought that by hanging a very small bar in the field of a large magnet, we might obtain just as many vibrations as by the use of a small apparatus: but this is not so, for Sir Wm. Thomson has shown* that the number of oscillations of a feebly magnetic or diamagnetic body of elongated form in a magnetic field is nearly independent of the length when that is short. So that the only way of increasing the number of vibrations is to decrease the size of the *whole* apparatus, or to increase the power of the magnets: the latter has a limit and hence we become dependent on the former.

The theory of the effect of the size of the body is very simple, and we may proceed as follows. Let the body be in the form of a small bar whose sectional area, a, is very small compared with its length, and let γ be the angle of the axis of the bar with the line joining the poles, and r the radius vector from the origin. Developing R^2 as a function of x and y by Taylor's theorem, and noting that as R is symmetrical with reference to the planes XZ and YZ, only the even powers of x and

* Reprint of Papers, Art. 670. Remarques sur les oscillations d'aiguilles non crystallisées.

y can enter into the development, we have, calling R_0 the value of R at the origin,

$$R^2=R_0^2+\frac{1}{2}\left(\frac{d^2(R_0^2)}{dx^2}x^2+\frac{d(R_0^2)}{dy^2}y^2\right)$$
$$+\frac{1}{2.3.4}\left(\frac{d^4(R_0^2)}{dx^2}x^4+6\frac{d^4(R_0^2)}{dx^2dy^2}x^2y^2+\frac{d^4(R_0^2)}{dy^4}y^4\right)+\text{ \&c.}$$

When the vibrating body is very small the first two terms will suffice: hence we have

$$M=\frac{1}{2}a\varkappa\left(\frac{d^2(R_0^2)}{dx^2}-\frac{d^2(R_0^2)}{dy^2}\right)\sin\gamma\cos\gamma\int_{-\frac{1}{2}l}^{+\frac{1}{2}l}r^2dr,$$

in which l is the length of the bar. If S is the density of the body (weight of a unit of volume), $I=\frac{a\,l^3\,\delta}{12}$ and n becomes

$$n=\frac{1}{\pi}\sqrt{\frac{\varkappa}{2\gamma}\left(\frac{d^2(R_0^2)}{dx^2}-\frac{d^2(R_0^2)}{dy^2}\right)},$$

in which, however, it is to be noted that $\frac{d^2(R_0^2)}{dy^2}$ is essentially negative and so the sign of the term containing it will be positive in the actual development.

This equation is independent of the dimensions of the body, and hence we conclude that when the body is small and very long as compared with its other dimensions, the number of vibrations which it will make in a given field is dependent merely on its coefficent of magnetization and on its density; a result first given by Sir Wm. Thomson, in the paper referred to. I have given it once more and put it in its present form merely to call attention to the facility with which $\varkappa$ can be obtained from it when we have measured R in different parts of the field by known methods. This could be done by means of a rotating coil as used by Verdet, or my magnetic proof plane which I will soon describe, combined with my method of using the earth inductor. This will give the best method that I know of for obtaining $\varkappa$ for diamagnetic or weak paramagnetic substances.

Troy, Jan. 15, 1875.

ART. XXXIX.—*On the Primordial Strata of Virginia;* by WM. M. FONTAINE.

MY investigations in the strata of the Primordial period in Virginia were confined to the immediate vicinity of the Blue Ridge, near Harper's Ferry, Rockfish Gap, Balcony Falls, and the Peaks of Otter. They extended to the rocks of the Cal-

ciferous epoch. These strata are well exposed along the west base of the Blue Ridge throughout the State.

The careful and accurate studies of these and the overlying formations, made by Prof. Wm. B. Rogers, have thrown much light on the complicated stratigraphy of the region. He shows that in the northern portion of the State, extending from Harper's Ferry to the south end of Page County, the Primordial slates are inverted so as to overlie the later formations on the west, and to pass with a high southeast dip under the like dipping strata of the Blue Ridge. In the middle counties, especially near Balcony Falls, these strata lie with a gentle northwest dip on the west slopes of the Blue Ridge. In some of the more northerly portions of this district, they lie immediately on the edges of the southeast dipping older slates, while at Balcony Falls and its vicinity the two systems of strata are separated by a ridge of syenitic rocks. Farther to the southwest inversion again occurs This inverted dip is found in all the strata of Silurian age and extends into those of the Devonian. The former occupy nearly all of the "Great Valley of Virginia," while the latter appear in the Great North Mountain, and its prolongations, which bound this valley on the west. The strata of the valley lie generally in a closed synclinal, producing a continued series of southeast dips. This compressed mass of rocks, on the west side of the valley, is thrust up against, and partly over, the Devonian strata, affecting them also with a southeast dip, producing a long line of fault, and bringing Hudson River shales up so as to overlie even strata of the Subcarboniferous period.

It will thus be seen that the amount of displacement produced is enormous. Owing to the contortions thus caused, and the possibility of repetitions from closed folds, all estimates of thickness, unless based upon long-continued examinations, must be received with caution.

I shall in this paper commence with the description of the section obtained at Balcony Falls. This I do because the strata there appear to present their normal development and dip; and also for the reason that here alone has Prof. Rogers given, in any detail, a description of the Primordial strata. It will be seen that my results do not agree entirely with his, and I must confess that I cannot reconcile them. In view of this difference, I should hesitate to maintain the correctness of my observations were it not that they are substantially verified by the section made at Rockfish Gap. This last was made along the cuttings for the railroad at that point, which were not in existence when Prof. Rogers made his examinations.

Before giving my own results at Balcony Falls, I will quote Prof. Rogers's description of the strata there found. He says:

"The formation (his No. I) here rests on igneous rocks, mostly syenitic in character, which form the main axis of the Blue Ridge. These are well seen along the pass. As we approach its termination, we mark the commencement of the rocks of No. I, which are seen on the side of the canal lying on the syenitic mass, with a northwest dip.

The lowest stratum next the syenite is a brownish, decomposing slate, evidently much altered by the syenite. Next is a grayish and reddish sandstone; then a slate similar to the former; then a repetition of the sandstone; again a slate, and, at the termination of the gap, heavy beds of massive white sandstone, the typical rock of this series. The average dip of the latter is, in the cliffs at the entrance of the pass, 55° northwest.

If we now return to the east, by the road leading over the mountain, we are accompanied for a long distance by these upper sandstones, and we then pass in succession over the underlying strata, which extend with a gentle dip almost to the summit of the mountain."

I now proceed to give the result of my own observations. Referring to a former article,* the reader will remember that the last rock described in the Balcony Falls section of the crystalline strata of the Blue Ridge, was a syenite of probably later age than the mass of the ridge. Next to this occurs the first of the rocks which I hold to be of Primordial age. We have: (1.) Unbedded quartzite, with crystals of feldspar. 120 feet. (2.) Brown, crumbling, argillaceous rocks or sandy shale, conglomeritic in its upper portion, 40 feet. (3.) Brown, decomposing, thinly laminated, and contorted shale, 10 feet. (4.) Conglomerate, like the upper portion of (2), 20 feet. (5.) Shales, like (3), 12 feet. (6.) Conglomerate, like (4), 15 feet. (7.) Crumbling, brownish shales, passing in the upper portion into argillaceous sandstones of the same hue and texture, 200 feet. (8.) Massively bedded, coarse white quartzite (apparently Rogers's typical No. I), 500 feet. Up to this point the rocks are well exposed in the cliffs which closely border the canal. Hence there is no danger of overlooking reduplications.

The dip of (3) is confused by contortion; that of (4) is 70°. From this point the inclination gradually declines, until in (8) it is about 55°. Proceeding west across the strike, we next encounter a series (9) of thinly laminated shales, with some beds of red and gray sandstones. This series is much more disturbed than the preceding, and, owing to its having been long subjected to the action of the river, in its efforts to cut through the massive barrier interposed by (8), it presents

* This Journal, January and February, 1875.

to the canal, slopes covered with debris. Hence details of the succession and dip of the strata cannot be given with accuracy.

A better exposure is given on the road mentioned above in Rogers's description. Here, too, however, great confusion exists. By far the greater portion of the mass is composed of thinly laminated, gray and reddish shales. Some beds of brick-red and gray sandstones of coarse texture occur, much indurated, and sometimes impregnated with epidote, chlorite, etc. Also, one or two beds of diorite apparently. Probable thickness, 600 feet.

To the west this is overlaid by a great series (10) of alternating beds of quartzite and kaolin shales. These rocks, where they join (9), present the same contortions and confused stratification, but in passing farther west, the folds open out, and are finally seen well displayed in the high mountain through which the river cuts its way at the "Cement Mills."

This mountain is the most westerly of the parallel ranges which compose the Blue Ridge at this place. At its western base the James and North Rivers meet, and force a passage, exactly at the point of junction. We thus find here the same features as those presented by the Potomac and Shenandoah at Harper's Ferry.

Standing at the Cement Mills, just where the river issues from the gorge and in this first barrier, the perpendicular walls of the opposite bank are seen to be composed of beautifully regular arches of No. (10), piled one above another to a great height. Probable thickness, 700 feet.

Both (9) and (10) seem, by a mighty thrust from the west, to have been crowded high up against the firm barrier opposed by the syenitic mass. This accounts for the gentle northwest dip which, as Prof Rogers correctly states, is shown by these upper strata in passing over the mountain to the east. In taking the section along this road, I did not find this to be true of the lower strata up to No. (8). They, even near the top of the syenitic mountain, show the same high dip that is seen along the canal. The massive, unyielding plates of No. (8) seem to have protected them to a certain extent, but have themselves been extensively fractured. Hence, in passing along the mountain road from the mills to the east, we observe the following typographical features: Looking westward, we see the strata of (10) rising and falling in rapid symmetrical undulations and forming the lofty range which fronts the valley of the river. Proceeding eastward, up the western slopes of the syenitic range, we pass first over the broken fragments of (10) and then of (9). Both, by the flattening out of the undulations, have a gentle northwest dip, and are partly crowded

over the fractured outcrop of (8). Next appear the lower strata in unchanged position.

Returning to the line of section, we find the western slopes of the mountain overlooking the valley of the James to be covered high up with boulders and alluvial matter, by which the junction of (10) with the next series (11), and some adjoining space, is concealed. The river has at some time flowed several hundred feet higher than its present level.

The series of strata which I have numbered (11) in this section occupies a narrow belt between the mountain last mentioned and James River. The dip is very regular, being about 55° to the northwest. The rocks, so far as seen, next to the mountain, are more or less ferruginous, and local pockets of iron ore occur in the sandstones of (10) forming the mountain, especially near the line of junction.

The first rock seen next to the mountain is thinly laminated, fragile shale, of yellowish and reddish hues, not fully exposed. Next, to the west, we have bluish calcareous slate, and slaty limestone, 50 feet. Then very thinly laminated, firm, deep red slates, 60 feet. Next a similar slate of blue color, 15 feet. Then a bed of dark blue, hard, and dense limestone, used for cement, 13 feet. Then thinly laminated red slates, 20 feet. Then coarser, and thicker bedded, blue slates, 40 feet. Lastly, a coarse, rough, massive, siliceous limestone, 40 feet.

These strata are all well exposed in the excavations made for gaining the cement stone. This group of impure limestones is the equivalent, in Virginia, of the "Calciferous sandrock," and is present at all the sections examined by me, holding a similar position with respect to the Potsdam strata. They present, also, remarkably constant features in composition, especially the last mentioned, which, both at Rockfish Gap and Harper's Ferry, may be recognized at a glance. The cement limestone, from its physical appearance, is the purest of the group. The following is its analysis, obtained from the owner of the mills: SiO_2 34·225; Al_2O_3 with a little Fe_2O_3 7·8; CO_2 30·4; CaO 17·380; MgO 9·513; KO ·12; water and organic matter, ·5; loss, ·062. The thickness of this group, up to the last mentioned limestone, is probably 600 feet, including the concealed ground. My section did not continue beyond this point.

On the west side of the river is a valley, from half to three-quarters of a mile wide, which is bounded on the west by a range of heights called "Salling's Mountain." I observed in the western banks of the stream about eighty feet of fine-grained kaolin shales and sandstone, like those of (10), but more shaly. These have the same northwest dip; how far they extend into the valley I do not know. Prof. Rogers says

that Salling's Mountain is composed of brown shales, which he makes the upper member of his No. I, or Potsdam formation. He further says that in them the dip is inverted, or to the southeast, the limestones of the Great Valley, i. e., the Trenton, Chazy, &c. (his No. II), passing under them. My section not having extended into these strata, I can say nothing concerning their age, except that they would seem to overlie the Calciferous sandrock, as the continued section above given extends through the Potsdam strata to those of the Calciferous. From this change of dip it appears that in this region the break and overturn of strata, which elsewhere extends through all the Primordial rocks, is found only in the strata overlying the Calciferous.

Some of the strata given in the above section present features of special interest, which must now be noticed.

The quartzite, No. (1), which immediately joins the syenite, is noteworthy as being the most completely metamorphosed rock seen in the entire section. This is evidently due to its contact with the crystalline rock. It is without bedding, and is affected by the same system of northeast and southwest joints seen in the syenite, and apparently forms one mass with the latter, no distinct line of junction being visible. The texture is nearly compact, from the fusion of the quartz grains. Numerous brilliant, perfectly crystallized, particles of white feldspar of small size occur. A few small, imperfectly crystallized garnets are seen in it. The next rock, No. (2), next to the quartzite, is a brown, crumbling, shaly mass, without bedding, which at its western edge terminates in a bed of feldspathic conglomerate. This has a high inclination to the northwest. The appearance of the lower portion of No. (2), and the highly altered condition of (1), seem to show that the upheaval of the adjacent portion of the syenite took place after their deposition, while the succeeding conglomerates are evidently the products of this disturbance. These conglomerates all closely resemble each other, and present some interesting features. They are composed of water-worn particles of quartz and red feldspar, of all sizes, up to that of a buckshot. The feldspar largely predominates, and is remarkable for its freshness, showing even in very small particles brilliant cleavage surfaces. Both it and the quartz are plainly derived from the neighboring syenite. The deposition must have taken place rapidly. The coarser particles are cemented together by a dark gray, very fine-grained paste, having the appearance, texture, and hardness of talc slate. It is apparently formed of finely comminuted feldspar and argillaceous matter. The entire mass weathers by exfoliation of concentric crusts, producing rounded boulders most strikingly like an igneous rock. Indeed, I

was induced by this peculiarity to study closely its composition, under the impression that such was its nature.

These conglomerates crop out on the top of the mountain, and are partially exposed in the road. Here I discovered that the upper part of No. (4) was composed of a mass of angular fragments of slate cemented together by conglomeritic matter. These fragments of slate, sometimes as large as the hand, are of precisely the same character as the argillites which make up so large a part of the Blue Ridge, especially to the north. Their existence here shows not only that these argillites are older than the lowest Primordial rocks, but that they were already in a metamorphosed condition prior to the Primordial Period. The shales lying between the beds of conglomerate are very much contorted, and they, with the succeeding strata up to (8), seem to be mainly composed of finely comminuted feldspathic and argillaceous material, which had not been long exposed to decomposing and dissolving agencies.

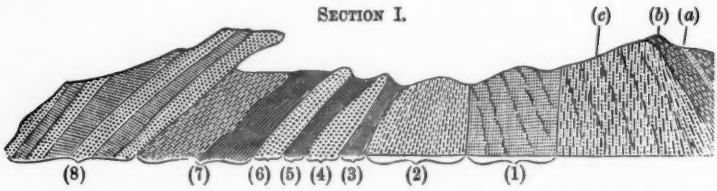
The massive beds numbered (8) in the section differ strikingly from the underlying rocks in every respect. The material composing them is almost entirely quartz and of a white color, the grains being more or less rounded and cemented together. A few specks of yellow earthy matter occur, marking the position of decomposed particles of feldspar. With this exception, the rock is remarkably free from all minerals except quartz. If I mistake not, this is the rock mentioned by Prof. Rogers as typical No. 1, or Potsdam. But from his descriptions, given elsewhere in his reports, the strata which I have numbered (10) coincide more nearly with his sandstone, No. I. This also agrees best with the relative positions of No. (10), and of the Calciferous sandrock, which forms the upper part of No. (11).

We may pass over the strata forming (9) in the section, as they lie in such confusion that it would be unsafe to attempt to give details. I may state, however, that the sandstones which occur in the shales of this series are quite thin. The coarsest and most massive layers are not more than 8 or 10 feet thick. It is worthy of note that these sandstones are much more altered than the shales by the disturbances to which they have been subjected. The shales seem hardly at all affected, while the sandstones are much indurated and often impregnated with epidotic and other metamorphic products. The material composing the shales is gray, argillaceous matter, with some beds of brown and reddish colors.

No. (10). This series, which is probably the equivalent of the Potsdam sandstone of New York, is composed of alternating strata of quartzite and kaolin shales. The quartzite layers vary in thickness from 20 feet to 3 or 4 feet. Many are quite compact, and some resemble vein quartz in fracture and other features.

The quartzites predominate in the lower beds. The kaolin shales often pass into a fine-grained sandstone, in which the grains of sand and kaolin of uniform size are equally and uniformly mixed. This latter rock, which is very common in the Potsdam of the northern part of the State, appears in great force at Rockfish Gap, and will be described in the section there more fully. The strata of (10) are remarkable for their freedom from coloring matters, and for the thorough decomposition of the feldspathic matter present. The kaolin shales and shaly sandstones occur in plates of a few inches to a foot or more in thickness. They are much fractured by the extraordinary disturbance to which they have been subjected. Notwithstanding the great amount of motion which has taken place in these strata, the shales do not seem to be metamorphosed beyond perhaps a partial loss of plasticity. Here again the sandstones show greater alteration. It is generally true, I think, that beds of pure argillaceous matter undergo far less metamorphosis in composition and texture than the siliceous layers which are interstratified with them. This at least is very generally true of the disturbed rocks of the Silurian and Devonian areas in Virginia and elsewhere, where I have observed them. The usual effect on these shales of the compression, &c., produced by disturbances is to cause them to assume more or less of the slaty cleavage, but I have never seen any approach to general crystallization of the constituents, even in the most profoundly convulsed districts. Again, the change in the beds of sandstone is usually the consolidation of the individual grains of sand. When foreign material is introduced, it is always in the form of local impregnations, plainly caused by circulating heated waters. I will return to this subject later. The strata of No. (11) do not require a further description.

The following section, No. I, represents the strata from (1) to (8) inclusive. No. (8) rises in a cliff 200–300 feet high, leaning over in an arch toward the syenite.



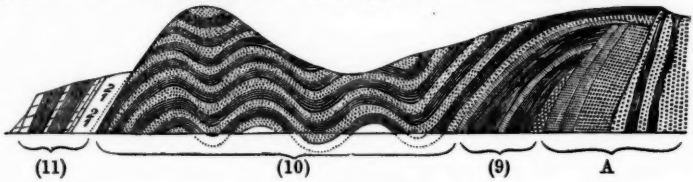
In this section, (*a*) represents the bed of quartzite mentioned in a former paper, as occurring on the east side of the syenitic mountain, while (*b*) denotes a portion of the mica slates which lean against this range on the east, with a southeast dip. The

strata numbered from (1) to (8) denote those thus numbered in the descriptions, while (*c*) represents the syenites against which these lean with a high northwest dip. This section represents the stratification on the canal, but on the slopes of the mountain ascending from the west (8) and the overlying strata are crowded over to some extent on the outcrop of the subjacent rocks.

From the occurrence of the quartzite stratum at (*a*), and the fact that the Primordial strata ascend to the summit of the syenitic mountain, it might, at the first glance, be supposed that the slates at (*b*) are merely the extension of the strata on the west in a more highly altered condition. But this idea is forbidden by the great difference in the thickness of the western and eastern quartzites, and by the total change in the character of the beds, those on the east being a great mass of mica slates, quite regularly bedded, and showing none of the alternations of strata seen but a little distance away on the west. This relative position of the two systems of bedded rocks explains the fact mentioned by Prof. Rogers as occurring in the more northerly portion of the State, where Primordial strata with northwest dip lie upon the edges of the slates of the ridges which dip to the southeast. This would occur here were the syenitic mass absent, and, as we shall see, it does not form a dividing ridge farther north. The following section, No. II, gives a representation of the stratification of series (9), (10) and (11). As far as (9) and (10) are concerned, it is in part ideal, and I do not insist upon the correctness of my estimate of their thickness.

SECTION II.

A. No. (8) with subjacent strata. (9) Gray and reddish shales and sandstones. (10) Potsdam shales and quartzites. (11) Upper shales and Calciferous strata.



PEAKS OF OTTER.

No detailed examination was made at this point of the Primordial rocks. At the west base of the syenitic range, gray shales and kaolin shales, very imperfectly exposed, were seen to pass a little distance up the mountain. They have a high southeast dip, showing the inversion of the lowest portion of the Primordial strata in this region. It is probable that some of the lower strata have been ingulfed in the overturn. Prof. Rogers states that from this point to the southwest the inversion generally prevails.

[To be continued.]

ART. XL.—*On the Silurian age of the Southern Appalachians;* by FRANK H. BRADLEY.

[Continued from page 288.]

[SINCE the previous part of this article was in type, another trip has been made from Athens to Murphy, by a road a short distance farther north than the one previously used. The section is essentially the same as that already reported, except that, after passing the soft schists of the Ducktown anticlinal, at the Hanging Dog Iron Works, the Ocoee and Chilhowee rocks, intervening between this anticlinal and the Valley River marble, have been forced past the vertical, and are exposed in inverted order, with northwesterly dips, until we have almost reached the valley at Tomotla, where southeast dips appear.

On page 284, line 13 from top, for "At Athens," read "Just south of Athens," for, about the railroad station, the Knox dolomyte shows an abundance of its characteristic chert, and the creek banks near the court-house have exposures of the shaly limestone of the Chazy epoch. The section was commenced perhaps a half mile south of the court-house.

Through inexcusable oversight, two errors have remained on page 286, after revision. As Safford's report and map both plainly show, the Knoxville fault passes a little north of the railroad at Athens, instead of two miles south of that place. The fault noticed at the latter point passes about nine miles south of Knoxville, where, though not mentioned in the section given, it separates the Cincinnati "iron-limestones" from the Knox dolomyte, both of which beds have there, locally, southeast dips. The Maryville outcrop of Knox dolomyte is thus shown to be the same one met with at Middle Creek and vicinity.]

5. *The Marble Belt.*

Three or four miles to the southwest of Dehart's, on Silver Creek, a tributary of the Nantahala, a heavy bed of marble is reported, which is supposed to carry silver ores. Farther southwest, perhaps ten miles from the Little Tennessee, its outcrop strikes the main valley of the lower Nantahala, not far below the Blowing Spring, and follows it, perhaps four miles, to Red Marble Creek, which it ascends to its head at Red Marble Gap, and thence descends Valley River. From the Blowing Spring to the Red Marble Gap the bed shows considerable quantities of a bright pink or flesh-colored marble, more or less variegated, in a patchy way, with various light shades of green and greenish-white, due mainly to the presence of more or less talc, which is sometimes in pieces large enough to make considerable flaws, or "dries," as the marble-workers call them. The value of the

material as an ornamental stone is still further diminished by the frequent dissemination of small grains of quartz through the mass, which prevent a perfect polish. At some points along Red Marble Creek, especially near its mouth, we find large portions of the marble even shaly, with talc or chlorite, or both, and very much disturbed and intermingled with chlorite schists. Some of these impure portions are of a rich chocolate brown. On the mountain-side, northwest of the creek, ascending the road leading from its mouth across to the head of Tallula Fork of Cheowa, we find a second outcrop of the marble, mainly blue and bluish-white and partly chloritic, held in the trough of a small subordinate fold, as was suggested with respect to the disturbed strata between Valley River and Cheowa. Higher up, the underlying chlorite slates are so much distorted that, at one point, dips of S. 60° E. and S. 55° W. were noticed within ten feet of each other, in the solid strata.

The local fold just mentioned seems to be converted into a fault, as we pass southwestward, toward Valleytown. The main line of marble-outcrop, passing through Red Marble Gap, runs by Swepson's and Ingraham's localities, making deep and long hollows as it crosses the mountain-spurs, crosses Junaluska Creek, near Valleytown, and apparently continues nearly to Paint Creek, where the overlying pyritous and micaceous limestone outcrops, just southeast of the fault. Higher up, as on Junaluska Creek, the marble is underlaid by siliceous, chloritic and hydromica schists, of the age of the Knox shale, followed below by gneisses, partly schistose, partly quartzytic, representing the Knox and Chilhowee sandstones, which latter form a high ridge, for several miles, between this lead of marble and the upper part of the Valley River valley. On the northwest side of the fault, the marble makes its appearance about a mile above Valleytown, outcrops at several points near Whittaker's house, where a little quarrying has been done, and continues, apparently without interruption, down the valley to Murphy, where it crosses the Hiwassee. Thence, crossing the lower course of Notla River, it crosses the lower part of Hemptown Creek, then crosses the Ocoee River and continues to the White Path gold mines and Ellijoy, in Gilmer County, Ga., where we shall meet it again. The line thus traced is, in direct course, over sixty miles in length. Without more detailed surveys along the whole line, we cannot be sure that there are no other breaks in its continuity; but, as thus far known, the Valleytown fault appears to be the only very important one. Just opposite Valleytown, a partial break exposes another outcrop of the underlying gneiss, between Whittaker's and Collett's; but the two strips of the marble are united, as they pass southwestward, at perhaps ten miles below Valleytown. In this neigh-

borhood, there are also local foldings of the overlying strata, but not such as to interfere greatly with the general regularity of the bedding.

Though the materials of the several outcrops are quite variable, yet the variation is of so constant a character in all, that one would have little hesitation in recognizing them as parts of one bed, even without the stratigraphical reasons for the conclusion. Along Valley River, and southwestward, the rock is mainly a bluish or grayish-white, fine-grained marble, the pink tinge of the Nantahala outcrops being rarely seen and then in very pale tints. One layer, from eight to twelve feet thick, is nearly black, or black-and-white striped, compact, and capable of taking a fine polish, thus forming a very beautiful ornamental stone, but still showing, under the glass, an oölitic structure like that of many of the lower layers of the unaltered Knox limestone. This was particularly noticed on J. T. Young's land, about a mile northeast of Valleytown, and at the mouth of Lenoir's shaft on lot "No. 6," near Murphy. The full thickness of the marble, near Murphy, is estimated at about four hundred feet.

Aside from disseminated grains of sand, which are sometimes very abundant, though at others entirely absent, the principal impurity of the marble is tremolite, which is sometimes present in quantity, either in separate, long, bladed crystals, or in finely radiated clusters, or in large, almost granular masses. It is said to form, at some points, considerable layers, consisting solely of it, which is certainly true at outcrops further south, near Gainesville, Hall County, Ga. As this mineral is essentially a silicate of lime and magnesia, it is natural to refer its origin to the abundant chert of the unaltered Knox dolomyte, which carries so much dolomyte in its intimate structure that it very readily disintegrates when exposed for some time to the action of percolating rain-water. At some points, as near Collett's, the marble is coarse-grained, and filled with small crystals of pyrite. At "No. 6," there is a thin layer of cellular quartz, possibly a true vein, filled with crystals of calcite, disseminated grains and masses of argentiferous galenite and some free gold.* The gravel along the outcrop, for several miles,

* The deep weathering away of the marble has caused the accumulation, upon the outcrop, of the gold originally disseminated through a large amount of rock; and surface-washings have therefore paid enormously.

The vein-stuff, at "No. 6," as exposed by shaft and drift, about fifty feet below the outcrop, shows the following section:—

White, fine-grained marble, with galenite, calcite and thin quartz veins,	5 to 6 feet.
Coarse-granular tremolyte,	2 to 6 inches.
Flinty quartz, with little calcite,	15 inches.
Yellowish-brown and greenish slaty limestone,	1 foot.
Green and brown, compact, knotty, hydromica slate, with disseminated pyrite, including streaks and thin layers of coarse-granular marble,	4 feet.

pays well for washing; and it is therefore inferred that this vein, or others like it, must be, so far, constantly present in the marble; indeed, similar vein-stuff has been seen in the outcrop, several miles up Valley River. I have not learned of the presence of sphalerite in the marble at any point.

One of the most common accompaniments of the marble, in this neighborhood, from the Blowing Spring to the Ocoee, and perhaps farther, is a bed of very pure steatite, or "cotton-rock," as it is locally called. This has been quarried, in small quantities, at several points, partly for the lining of furnaces at the Ducktown Copper Works, partly for the making of the so-called "lava" tips for gas-burners. Mr. A. A. Campbell of Tomotla, who has quarried much of it, tells me that he has sometimes found it filling small basins in the surface of the marble; but, as I understand his statement, this may have resulted from local sharp folds of the strata, and the steatite may still be a regular overlying layer conformable with the marble, as I believe to be generally the case. The outcrops, however, are not favorable to a decision on this point. At Tomotla P. O., the steatite lies in a bed, 8 or 9 feet thick, *below* the marble, and separated from it by a bed of granular quartzyte. Below the limit of precolation and consequent decomposition, the steatite is of a rich green tint, translucent, and endures sudden heating; when partially altered, it is opaque, of a rusty yellow color. and, by reason of absorbed water, splinters when quickly heated, but gradually hardens like the unaltered rock. At one pit, on Notla River, the surface is covered with a dense blue mud, which appear to be the ultimate result of underground decomposition. The rock sometimes contains tremolite crystals.

The marble is also pretty constantly accompanied, hereabout, by thin beds of cellular chert and itacolumyte (flexible sandstone), sometimes separate, sometimes running into each other. These, I believe, mainly overlie the marble. A good point for examining them is the neighborhood of Red Marble Gap.

Heavy beds of limonite, compact, cellular and ochreous, partly pure, partly cherty, also follow the outcrops of the marble, and have been mined, or rather quarried, at several points, for the supply of small furnaces and forges. These are of essentially the same character as the limonites which are so abundant along the outcrops of the unaltered or slightly-altered Knox dolomyte throughout East Tennessee, Georgia and Alabama, and extend northeastward to New England and Canada; but some of them are considered to be exceptionally pure. They are said to carry, at most points, small amounts of gold and silver, though rarely enough to make them worth working for those metals. These ores occur at four well-marked horizons, one immediately beneath the marble, the others above it,

as shown in the accompanying section of the rocks at and near Murphy:

1. Hydromica schists, smooth and wrinkled, ferruginous, with garnets, staurolites, titanic iron and gold—some quartz veins.
2. Fine-grained chloritic gneiss.
3. Talcoid schists, with mica crystals.
4. Dark greenish-black hornblende rock, with garnets.
5. Micaceous limestone, with pyrite, weathering to *limonite* ..... 500 + feet.
6. Hydromica schists ..... 150 "
7. *Limonites* (rarely mined) ..... 50 to 70 "
8. Hydromica schists ..... 100 "
9. Knotty quartzytes ..... 65 "
10. Hydromica schists ..... 25 "
11. Slaty steatyte, ... 30 "
12. Soft schists and gneisses, with streaks of speckled mica slates, ... 250 "
13. Hydromica schists, with *limonites*, ... 150 to 200 "
14. Marble ..... 400 "
15. Limonites ..... 100 to 200 "
16. Quartzyte.
17. Heavy-bedded gneiss.

No. 5 of this is the evident source of one of these limonite belts: and the others may very probably have similar origin; but I have not seen any exposure of the strata beneath them. This pyritous limestone was seen in the ridge between Professor Olmsted's house and Lenoir's shaft, near Murphy; also at the Parker gold mine, 11 miles northeast; also near Whittaker's (now Ross's) Mill, 14 miles northeast; also on Paint Creek, near Valleytown. The heaviest outcrop seen is at the Parker Mine. As the section shows, this bed, near Murphy, lies about 900 feet above the marble, which we suppose to represent the Knox dolomyte, though much thinner than that group is in its Tennessee exposures. This distance would not vary much from the space separating the Knox from the iron-limestone of the Cincinnati group near Knoxville, and I am strongly impressed with the belief that the pyritous and micaceous limestone is the equivalent of this latter bed, because of both its chemical composition and its position. The hornblende rock of No. 4 of the section may perhaps be included, since the dark-colored hornblendes are essentially silicates of lime, magnesia and iron; but, if so, we must also include all the overlying beds of the section, since rock of precisely the same characters occurs, in thin layers, at intervals, throughout the schists of No. 1, on the ridge back of the Parker Mine. I am at present inclined to thus include these schists, and so to refer the whole upper part of the section to the Cincinnati group.

About four miles above Murphy, on Peachtree Creek, another outcrop of marble occurs, which *appears* to be the equivalent of that already discussed, which requires the existence of a considerable fault somewhere between the two outcrops. I am not entirely certain as to the location of this fault, since the strata vary locally to such an extent, hereabout. I believe, however, that it is very close to the Peachtree outcrop. Accordingly, I would refer all the intervening strata to either the upper part of the Cincinnati group or the overlying beds of the Silurian. Ascending the Hiwassee, after leaving the auriferous hydromica schists of No. 1 of the foregoing section, which underlie most of the town of Murphy and extend nearly a half mile up the river, we find, first, a fine-grained, ferruginous micaceous, quartzytic sandstone; then, a thin bed of chlorite slate; then, a thousand feet or more of fine-grained gray sandstones, with quartz veins; then, white, gray and ferruginous quartzytes, partly heavy-bedded, with pyritiferous quartz veins, interlaminated with siliceous mica slate and hydromica schists, at least three thousand feet in all; then, several hundred feet of mottled hydromica slates, with mica crystals, a few staurolites, and some gold. This brings us to the mouth of Peachtree, on the line of strike of this marble outcrop: though the marble does not appear near and south of the crossing of the Hiwassee, yet the accompanying limonites, which are abundant on Peachtree, are also largely developed beyond the river, and a low valley, evidently eroded in soft strata, runs on for some miles toward the upper course of the Notla River. On Peachtree Creek, near M. L. Brittain's, the marble shows white, blue, gray and reddish-brown layers, the darker varieties being often quite impure with streaks of schist, partly siliceous. Beneath them, a pyritous steatite occurs at one point, which must be the equivalent of the "cotton-rock" above described; but the exposed outcrop is much more impure than that on Valley River and Notla. Above the marble, there is here a garnetiferous schistose brown limestone, which graduates into a calcareous mica schist. These beds, over 2,000 feet thick, form a high ridge, which, in its more eastern portion, between the two forks of Peachtree, is known as Breeding Mountain: an isolated portion lies between lower Peachtree and the Mission farm on Hiwassee River; and, south of the river, the line continues on between this belt of marble and Little Brasstown Creek. Just beyond this, another fault again brings up the marble, which outcrops at several points on Little Brasstown and on and near the Mission farm, being accompanied as usual by heavy beds of limonites. These limonites, both here and on Peachtree, are largely ochres, and are said to contain considerble amounts of silver, copper and lead. Above the Mission farm, the overlying

calcareous mica schist forms another high ridge, which comes sharply to the river bank on both sides. Those two belts of marble are apparently broken off toward the northeast, though each has been traced some distance into the mountains, by lines of sink-holes. They probably reach the more southern branches of Vengeance's Creek, but do not appear on its more northern ones. Their southwestern continuations have not been traced continuously; but outcrops of marble, representing one at least and probably both, occur on Notla River, about at the State line. The marble of Jasper, Pickens County, Ga., is probably on the continuation of one of these belts.

In passing on up Brasstown Creek, we find principally mica and hydromica slates and schists, with many staurolites and small garnets, and increasingly numerous quartz veins which, as we approach the Georgia line, become pyritous and frequently auriferous. On both sides of the line, veins rich in gold have been opened, though none has yet been extensively worked. Two small stamp-mills are now running, in this neighborhood. In some of these veins, argentiferous galenite occurs in considerable quantities.

Somewhere near this point, both Emmons and Kerr indicate a great fault, separating the so-called "Taconic" or "Huronian," on the northwest, from the "Azoic" or "Laurentian," on the southeast. I cannot certify to the non-existence of such a fault; but I have crossed its supposed line and the succeeding belt of country for several miles, on three distinct routes, without having found any appearance of unconformability or any very marked change in rock characters, except that hornblendic strata become more numerous at some points. In ascending the Little Tennessee, from where we have supposed the main belt of marble to cross it, we find schists and gneisses dipping southeasterly, until within nine miles of Franklin, where northwesterly dips set in, continuing about five miles, until we meet with decayed, auriferous, hydromica schists dipping 45° to 60°, to N. 10°–15° E. As this has been the eastern limit of my explorations, I am not *sure* that this may not mark an approach to another series of rocks; but the character of the material does not indicate this, and I am inclined to believe that the *northeasterly* dips are only local, and that the limestone reported by Dr. Curtis as existing in considerable quantity on the western slope of the Cowee Mountains, about eight miles east of Franklin, is really the southeastern edge of the synclinal of which the Nantahala and Valley River outcrop is the northwestern. At least, I have found no definite boundary to the Silurian in this direction.

If there are *any* non-Silurian beds in this region, they are those which form the higher portions of the Valley River

Mountains and Nantahala Mountains. On the lower Nantahala, opposite the mouth of Red Marble Creek, an extensive outcrop of chloritic gneisses, dipping 55°, S. 65°–70° E., commences about two hundred yards southeast of the marble, which here dips 57°, S. 57° E. The intervening space is covered, but there is no indication of the presence of the pyritous, micaceous limestone which, farther southwest, occupies nearly the place of these gneisses. In this region of great disturbance, neither the variation in dip nor that in lithological character is sufficient to justify the inference of unconformability; yet there *may* be a fault here and displacement either up or down on its southeast side. Leaving the marble at Valleytown, and following the direct road to Franklin, we first cross a wide outcrop of hydromica schists; then, a thin bed of laminated quartzyte; then, chloritic and mica schists, gradually becoming more compact and siliceous and including some quartzytes. Until we pass the summit of the Valley River Mountains, at Morgan's Gap, the dips vary from 35° to 60°, and from S. 20° E. to S. 45° E., apparently in consequence of warpings of the strata rather than of any true unconformability; but, upon the eastern slope these are replaced by dips varying from S. 20° E. to S. 60° W., as if in the greatly disturbed strata about the axis of a very irregular synclinal. Both gneisses and schists here show more mica than chlorite. The irregularity of the dips continues until we pass the summit of the Nantahala Mountains, where the synclinal character of the region appears to be more strongly marked in sharp northwesterly dips, which continue down the southeastern slope. The rocks have become less schistose and more gneissoid, and include much hornblende. After reaching the valley, we encounter the auriferous hydromica schists, dipping N. 15° E. as before stated, which continue to Franklin. While I have not made sufficiently detailed examinations to be *certain* that these disturbed strata of the upper Nantahala are not of greater age, yet what I have seen of them has given me a very strong impression that they are *newer* than the Valley River marbles. This impression has only been strengthened by a trip from Parker's Mine to the head of Vengeance's Creek. Along this line, chloritic schists, which *must* be above the marble, gradually pass into others a little more compact and siliceous, (the precise equivalents of those first encountered on the Valleytown-Franklin road,) with laminated quartzytes. Near the summit, these include a considerable thickness of fine-grained nearly black mica slates, becoming siliceous above and striped with quartzytes.

In passing southeastward from Brasstown Creek toward the head of Hiwassee River, we find southeast dips at first; but these soon begin to alternate with northwesterly ones, showing

such small local wrinkles as we should naturally expect along the somewhat irregular axis of a sharp anticlinal. Hornblendic layers here become rather more abundant, though there are still several belts of soft hydromica schists, with thin quartz bands, some of which are rich in gold. One of these latter, continued westerly, passes Blairsville, Union County, Ga., where rich ore has been found, though no systematic mining has been attempted. About two miles south of Hiwassee, Towns County, at Ivy Mount Mine, some of the hornblendic layers include copper ores, similar to those of Ducktown, though not yet fairly developed. Old works, followed on a small scale before the war, have recently been re-opened, and show very promising bodies of ore.*

Passing on southward, on the Unaka Road, we find the dividing ridge, or Blue Ridge proper, consisting of mostly heavy-bedded gneisses, partly hornblendic, with some schistose portions, all dipping northwesterly in a regular monoclinal. Descending the southern slopes of this last prominent range of the Appalachian chain, the foot slopes show a broad outcrop of the soft auriferous mica schists, with thin irregular quartz veins and occasional layers of gneiss, quartzyte and itacolumyte. These appear to be the opposing edges of the set of beds passing Hiwassee and Blairsville.† The recognized "gold belt" extends to beyond the Chattahoochee, and mining has been carried on, in the small way, at a great many points. Near Cleveland (formerly called Mount Yonah), we reach the axis of an anticlinal, along which appear heavy-bedded gneisses, which form an interrupted line of high knobs, running parallel with the main mountain. Of these, Yonah Mountain, in White County, and Walker's Mountain, in Lumpkin County, are the more prominent. These beds yield no gold; but the auriferous schists immediately recur and show almost continuously for at least sixteen miles south of Clarksville, Habersham Co. Southeasterly dips continue from the Yonah anticlinal to about ten miles south of C., where the synclinal of the Chattahoochee Ridge gives us northwesterly ones, which continue about five miles, to near Hollingsworth, where we pass another anticlinal and again find southeast dips. Besides the hydromica schists, with quartz veins and bands, which constitute the mass of the strata, we find some chlorite slates, and a few beds of gneiss, the latter partly granitoid, partly porphyritic. A few miles east of Clarksville, considerable quantities of marble have been

* The inclosing wallings are of very compact gneiss, partly hornblendic. The ore is pyritous, and carries large amounts of zinc-blende (sphalenite). The quartz gangue is at some points full of apatite, from whose alteration we have, in the crevices about the lower limit of decomposition, considerable surfaces of vivianite, in pale blue crystals.

† In mining reports upon this region, prepared in 1861, W. P. Blake described these strata as being metamorphosed Paleozoic.

quarried and burned into lime. The position of this outcrop indicates that the bed probably has a southeasterly dip, passes very near Clarksville (possibly along the depression of the valley of Soquee Creek), and is continuous with the outcrop at Limestone Spring, about two miles east of Gainesville. This bed must also occur on the north side of the anticlinal, along the foot of the mountain, but is not yet reported. In passing from the Yonah anticlinal direct to Gainesville, Hall Co., a second anticlinal axis is passed, near the crossing of the Chattahoochee, which is apparently not developed much farther east, as it was not seen on the Clarksville road. Near this river crossing, at the Glade Mines, a prominent bed of itacolumyte is reported; and several diamonds have been found in the gold washings. The marble, near the Limestone Spring, is essentially the same as that of the Valley River belt, but contains, perhaps, rather more impurities, heavy layers being here solid masses of tremolite. So far as seen, the immediately overlying beds were so covered with debris as to prevent comparison with those seen about Murphy. The Glade mines being very near this belt, one naturally connects the heavy limonite beds of that place with the similar ones of Murphy and vicinity. Silver ore is also reported from this vicinity.

Passing westward and northwestward from Gainesville, we reach the second anticlinal, just mentioned, about a mile from town, with dips at first about S. 75°–80° W., which are the first indications of approach to the irregularities which mark the *southwestern extremity of the Blue Ridge proper.* The local facts to be stated will perhaps be best understood if the general features of this southern part of the range are first briefly set forth. The Blue Ridge, which is a single range in northern Virginia, forks a few miles southwest of Lynchburg; and the two ranges thus formed gradually separate, to the southwestward, until, in middle and southern North Carolina, they are from sixty to seventy miles apart. The main strikes are S. 45°–65° W.; and, in the eastern range, which is the main watershed, these continue through Georgia into Alabama; but the western range, almost from the very point where it enters Georgia, bears more to the southward, the strikes being mostly about S. 5°–15° W., and rapidly approaches the eastern. This western range, as such, terminates before reaching the Etowah River; but the disturbances consequent upon the crowding of folds have been felt far to the southward and eastward, as we have seen.

After crossing the Shallow Ford of the Chattahoochee, we find more nearly the normal dips of this side of the anticlinal, in a heavy outcrop of thin-bedded gneisses, which dip 30°, N. 62° W., and in the overlying auriferous hydromica schists,

banded with thin layers of quartz and hornblendic gneiss. As we approach the synclinal, disturbed dips again appear. We here reach nearly the horizon of the marble, but pass the synclinal axis without its appearance, about a mile west of the Chestatee River, which we cross near Robbins's mill. Dips of S. 25°–40° E., in gneisses and schists, continue until we have passed Crossville, Smithville and Barretsville, and have crossed the Etowah at Leadbetter's Ford. Somewhere in this space the marble must occur; but it was not seen in passing along the road. About twelve miles south of Jasper, we reach the line of probably the greatest crowding of folds and disturbance of dips. For the next four miles northward, the rocks are mainly hydromica schists and gneisses, with quartz and granite veins. Within this space, the following succession of dips was noted: N. 35°–70° E.; N. 20°–30° W.; S. 20°–70° E.; S. 35° W.; S. 60° E. From this latter point we find more regular southeast dips (S. 50°–85° E.) to beyond Jasper, Pickens County. As we approach the crossing of Long Swamp, at Tate's, about five miles south of Jasper, we see by the roadside a cliff of white and gray granular marble, partly quite pure, partly quartzose, dipping 32°, S. 62° E. Considerable quantities of the purer beds have been quarried near here, and at other points along the Swamp to above Jasper. From quarries now worked about a mile east of the town, I have seen specimens as pure and fine-grained as the best statuary marble, but am not informed as to the amount of such rock. This is probably the direct southern continuation of one of the Knox marble outcrops, which pass south of Murphy. The Knox shale appears to have been locally wanting, since heavy-bedded gneisses, which we must refer to the underlying sandstones, show considerable thickness along the western border of the Swamp; but fine-grained mica slates occur near this horizon, from two to four miles north of Jasper. Hence to Ducktown, we follow nearly the general line of strike, and pass over pretty continuous lines of gneisses and schists, with variable southeasterly and northeasterly dips. The marble outcrops are known, at short intervals, along to the right of the road and at gradually increasing distances from it. At Tolono Creek we cross what may be the continuation of the Valley River belt. The copper is on the left of the road, but has not been exploited, I believe, at any point south of the Mobile Mine, in Fannin County, five miles from Ducktown, where there were extensive works before the war, which are now in ruins.

To the southwestward, the copper-bearing strata appear, in Harraldson, Paulding and Carroll Counties, with nearly the regular northeast strike, but apparently broken up by faults, so as to show three approximately parallel lines of outcrop,

without intervening folds. These have not been traced so closely through the intervening country that I can feel certain which, if either, is the exact equivalent of the Ducktown line. The more northern line passes through the Waldrope Mine, in lot 932 of the third district of Harraldston County, where a good ore-body, from eight to fourteen feet thick, has been exposed in a shaft about sixty feet deep. The dip is here about 45°, S. 55° E. Near the Gamble shaft, on lot 851, a heavy bed of compact red hematite runs parallel with the copper, and but a few rods from it. The second belt passes close to Drake-town, Paulding County, where the McClarty shaft, 105 feet deep, showed from twelve to eighteen feet of not very rich ore. The dip is here about 80°, S. 47° E. The third belt passes about a mile north of Villa Rica, Carroll County, where several small shafts have been sunk, along the outcrop, and have shown, according to reports, from three to thirteen feet of ore, partly poor, partly rich. Near the eastern termination of the recognized outcrop of "copper gossan," large numbers of polarized fragments of magnetite are scattered over the surface; and these increase in size and number as we pass eastward; but the bed has not been traced far beyond the point where signs of copper disappear. This deposit is an interesting one as a continuation in oxyds of a belt of sulphides farther west. The iron looks rather like a titaniferous ore, but has not been analyzed. While these three belts show but slight lithological variations, the strata being mainly hydromica and talcose schists, with occasional belts of hornblendic gneiss, and are therefore probably referable to one series broken by two faults, they *may* represent two or even three horizons.

At Villa Rica, we reach a synclinal fold; and the copper-gossan appears on its southeastern side, with northwestern dip, a short distance to the southeast in Douglass County. This is probably the belt on which a little work has recently been done at several points near Carrollton, while, still farther west, Wood's Mine, in the edge of Alabama, has, for about a year, been yielding large amounts of rich ore. Along the axis of this synclinal, for a width of between one and two miles, we find a belt of hydromica schists, with several quartz bands, both thick and thin, carrying considerable gold. This has been mined at several points; and several millions are known to have been coined from this immediate neighborhood, mostly washed from the stream rubbish and decayed outcrops, but partly obtained by stamping the vein-stuff. Gold-bearing strata have been recognized near each of the two more northern belts of copper; but little work has been done upon them. The gold-bearing schists of Bonner's Mine, eight miles southeast of Carrollton, have more of the appearance of the higher

strata of the upper Chattahoochee waters, and probably are their continuation, though the marble belt, which is the only horizon thus far certainly recognizable, has not yet been reported from this region, nor, indeed, from any point west of Atlanta. Dr. Stephenson reports that it passes about ten miles north of that city.

The evidence is certainly very strong that *all the strata of the region thus reconnoitred are of Silurian age.* The only exception thus far suggested is that of an area east of Marietta, Cobb County, Ga., where Dr. Little reports the surface covered with masses of partly decomposed massive granite, over an area two or three miles in diameter. This *may* be Archæan; and there may be other similar islands within the area indicated but I have not yet seen or heard of any. Tuomey's reports upon Alabama indicate that the metamorphic strata of that State are of the same character and age as their continuations in Georgia.

To the northeastward of the region visited, we have as yet nothing definite. Emmons says, however (l. c. p. 31), that "the prevailing dip of the rocks of the Blue Ridge is southeast. When, however, we have passed from the pyrocrystalline rocks to the Taconic system, the dips are changed, first to southeast and finally to northwest, which is the prevailing dip." In view of the facts observed upon the same belts in Georgia, and herein recorded, it seems fair to suggest that, in North Carolina also, the Blue Ridge is probably simply a synclinal, with local irregularities of dip along the axis; and that the "pyrocrystalline rocks," as well as the "Taconic," are *probably all Silurian*, instead of being "Azoic" or "Laurentian."

The question naturally presents itself: *When occurred the uplift and metamorphism of all this region?* We have as yet no *direct* evidence—as that of newer horizontal beds lying unconformably upon the edges of these strata—but the indirect evidence is strong. Aside from the beds recognized as genuine Archæan, none give signs of any disturbance prior to the date of the general upheaval which affected the entire series, to the top of the Coal-measures. Both the disturbances and the metamorphism, from the Cumberland Mountains to the eastern range of the Blue Ridge, at least in this lower portion of their extent, appear to belong solely to one system and time. Further, so far southeast as the foot of Chilhowee Mountain, we find Subcarboniferous strata, in regular position, involved in the disturbance; and there seems to me to be every reason for believing that the Coal-measures also once covered the entire region. The entire disturbance must then be considered *post-Carboniferous*, and is doubtless referable to the close of the Paleozoic.

Although the Smoky Mountains are as high as the Blue Ridge proper, and yet give passage to streams from the latter range, it is not necessary to infer the earlier elevation of the Blue Ridge, as Willcox has recently done (Proc. Philad. Acad., 1874, p. 165), for the more thorough metamorphism of the eastern range is sufficient to account for its greater resistance to erosion during the earlier ages. On this subject of erosion, I hope to speak further, at another time.

I must here express my acknowledgments for local information furnished me by Prof. E. B. Olmsted, of Murphy, Mr. J. Mack Whittaker, of Valleytown, Dr. Josiah Curtis, now of Washington, D. C., Messrs. J. R. Dean and R. R. Asbury, of White County, Ga., Dr. M. F. Stephenson, of Gainesville, R. J. Gaines, of Carrollton, Dr. George Little, State Geologist of Georgia, and Mr. W. L. Nicholson, Topographer of the Post Office Department, Washington, D. C.

Knoxville, Tenn., March 27th, 1875.

ART. XLI.—*Brief Contributions from the Physical Laboratory of Harvard College.* No. 15.—*On the construction of Gaugain's Galvanometer*; by JOHN TROWBRIDGE.

IN this instrument the law of the proportionality of the strengths of the electric currents, circulating through the coil of the galvanometer, to the tangents of the deviations of the needle, is exact when the distance of the center of the needle from the center of the coil is equal to one-half the radius of the coil. The theoretical demonstration by Bravais of the truth of this law of the galvanometer leads to the expression

$$\text{Eq. (1.)} \quad i=\frac{T\rho^3}{2\pi R^2}\left[1-\frac{3l^2}{2\rho^2}+\frac{15l^2D^2}{\rho^4}+\frac{15l^2}{4\rho^4}(R^2-4D^2)\cos\delta^2\right]^{-1}\tan\delta$$

in which i=strength of current.
T=horizontal intensity of the earth's magnetism.
R=radius of coil or circular wire.
l=length of needle.
D=distance from center of needle to center of coil.
$\rho^2=l^2+D^2+R^2$.
δ=deviation of needle.

We see from eq. (1) that when $(R^2-4D^2)=0$, or $D=\frac{R}{2}$, that the terms in the parenthesis are of the order $\left(\frac{l}{\rho}\right)^4$ and when $\frac{l}{\rho}$ is small these can be neglected.

In constructing the galvanometer the serious question arises: how much will a small error in the measurement of D and of R affect the law? and which will have the greater effect, an error in the measurement of R or in that of D?

Let us suppose at first that R and D have been measured correctly. We shall then have

$$i=\frac{T}{2\pi R^2}(l^2+R^2+D^2)^3\tan\delta, \text{ in which } D=\frac{R}{2}.$$

Suppose now that, while R remains constant D differs from its true value by αD, in which α is a very small quantity. We shall then have, neglecting small quantities in Eq. 1:

$$i=\frac{T}{2\pi R^2}(l^2+R^2+(D+\alpha D)^2)^3\tan(\delta-m)$$

in denoting the decrement of the angle of the needle. The difference in value of these two expressions for the strength of a current is

$$i-i_1=\frac{T}{2\pi R^2}\Big((l^2+R^2+D^2)^3\tan\delta-(l^2+R^2+(D+\alpha D)^2)^3\tan(\delta-m.\Big)$$

Suppose now that D remains constant or R varies from its true value by the small quantity βD, in order to produce the same decrement as in the angle; we shall have

$$i_2=\frac{T\,(l^2+D^2+(R+\beta R)^2)^3\ \tan\,(\delta-m.)}{2\pi\,(R+\beta R)^2}$$

$$i-i_2=\frac{T}{2\pi}\Big[\frac{(l^2+R^2+D^2)^3\tan\delta}{R^2}-\frac{(l^2+D^2+(R+\beta R)^2)^3\tan(\delta-m)}{(R+\beta R)^2}$$

The difference in the values of the strengths of the currents are indicated by the final terms in the values of $i-i_1$ and $i-i_2$ which are

$$\frac{(l^2+R^2+D^2\,(1+\alpha)^2)^3\tan\,(\delta-m)}{R^2}$$

and $$\frac{(l^2+D^2+R^2\,(1+\beta)^2)^3\tan\,(\delta-m)}{R^2(1+\beta)^2}$$

Since $D=\frac{R}{2}$ we have by developing and neglecting the squares of α and β,

$$\frac{\Big(l^2+\frac{5}{4}R^2+\frac{R^2\alpha}{2}\Big)^3}{R^2} \quad \text{and} \quad \frac{\Big(l^2+\frac{5}{4}R^2+2\beta R^2\Big)^3}{R^2(1+\beta)^2}$$

Neglecting α and β when they are additive to a large whole number, the differences in the strengths of the currents will be expressed by the terms $\frac{\alpha R^2}{2R^{\frac{2}{3}}}$ and by $\frac{2\beta R^2}{R^{\frac{2}{3}}}$, α is smaller from the nature of the case than β. Hence

$$\frac{\alpha R^{\frac{4}{3}}}{2}<2\beta R^{\frac{4}{3}}.$$

Therefore an error in the measurement of R will not affect the law of the galvanometer so much as one in the measurement of D.

In order to obtain an idea of the magnitude of errors resulting from changes in the value of D, I arranged a galvanometer so that the coil, consisting in this case of a circle of thick brass wire, the resistance of which could be neglected, could be moved away from its true position, after the manner of Wiedeman's galvanometer. The value of R was 12 cm. and that of D 6 cm.

Value of D+X	Value of δ.
6	20°
7	19
8	18
8·5	17·5
9	16·5

A variation of 1 cm. produced a change in the deviation of the magnetic needle of 1°. (The galvanometer needle was 25 mm. long and was suspended by a single fiber of silk.)

The apparatus was also so arranged that the radius of the circle of brass could be changed, while D remained constant. It was found that the changes in the indications of the needle were inappreciable until the increase of the radius was 5 mm. when the increase amounted to 1 cm.,—a variation of half a degree was produced in the indication of the needle. The increase in resistance of the circuit was inappreciable. An error, therefore, of five millimeters in the determination of the radius of the coil was inappreciable, while the same error in the measurement of the distance of the needle from the center of the coil resulted in, comparatively, a larger error. In approaching the subject from another point of view, it can be proved* that the expression for the attraction of a single circular current on a point situated on the line passing through the center of the coil and perpendicular to its plane is

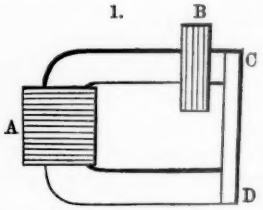
$$X=2\pi k\left\{\frac{a^2}{r^3}-\frac{3a^4}{2r^5}+\frac{15}{8}\frac{a^6}{r^7}-\ldots\ldots\right\}$$

in which k is a constant depending on the strength of the current, a is distance of point from center of coil, and r is the radius of the coil. By inspection it will be perceived that a small variation in the value of a will affect the value of X more than a similar slight variation in the value of r.

* James Stuart, M. A., Phil. Mag., 46, 1873, p. 231.

No. 16.—*Upon the induced currents produced by the application of armatures to Horseshoe magnets and a new form of Magneto-electric Engine;* by W. R. MORSE.

The apparatus consisted of cylindrical horseshoe electro-magnets, the wires of which were wound about the iron cores at the bend of the iron, so as to form practically straight electro-magnets with cores horseshoe in form. Upon one of the limbs of the horseshoe core a coil of fine wire was slipped so that the plane of its coils was at right angles to those of the electro-magnet. In fig. 1, A represents the coil of the electro-magnet; B that of the induction coil. Upon exciting the electro-magnet induction currents arose in the coil of fine wire B both at making and breaking the circuit. These currents were measured by a reflecting galvanometer placed in the circuit of the coil B; and were compared with those obtained from the same electro-magnet by placing a straight armature C D upon its poles and then exciting the electro-magnet. The following table shows the results obtained. Only the currents resulting from making the circuit are recorded, those proceeding from the breaking of the circuit being the same in value. The readings are expressed in the divisions of the scale of the reflecting galvanometer.



Without armature.	With armature.	After removal of the armature. 1st deflection.	After removal of the armature. 2d deflection.
170	210	210	170
170	209	209	170
175	209	209	170
170	210	210	175

These results show that a marked increase (in these experiments, nearly twenty-five per cent) in the strength of the induction currents results from the application of an armature to the poles of the electro-magnet. The third and fourth columns of the table show that after the removal of the armature, the first induced current which results from again making the current in the electro-magnet shows the same increased effect; but that the following current resulting from breaking the circuit of the electro-magnet falls to its normal amount. This result is noteworthy, for it shows a certain molecular change in the iron which results from the application of the armature.

Although we can thus increase the strength of the induction currents produced in coils slipped upon the limbs of an electro-

magnet, we diminish the lifting power of these individual limits by the employment of an armature, as the following results show:

Weight lifted without armature.	Weight lifted with armature on.
249	160
300	180

In the preceding experiments the straight iron bars forming the armatures were carefully deprived of whatever residual magnetism they might possess.

Experiments were next tried upon the effect of horseshoe electro-magnets used as armatures to electro-magnets of the same character as those employed in the preceding experiments. When two north or two south poles were opposed to each other, and the magnetic circuit, so to speak, of the two horseshoe-shaped cores was closed, very feeble indications were shown by the galvanometer. When, however, a north and a south pole were opposed, and the magnetic circuit closed, the strength of the currents obtained both on the application and the removal of the armature were very marked, as the following results show:

At contact of N. and S. poles.	On removal of N. and S. poles.
+360	−359
+362	−360
+361	−361

When the horseshoe magnet forming the armature was not used, and one of the limbs of the stationary electro-magnet was quickly slipped in and out of the induction coil, induction currents were obtained, the values of which are shown below:

Placed in.	Withdrawn.
+40	−40
+40	−40
+40	−40

In these experiments the stationary electro-magnet and the electro-magnetic armature were of the same size and the same magnetic strength.

Experiments were next made upon the influence of the mass of the iron forming the armature. This was found not to have so much influence as the residual magnetism of the iron. The results were very contradictory, as the following table shows:

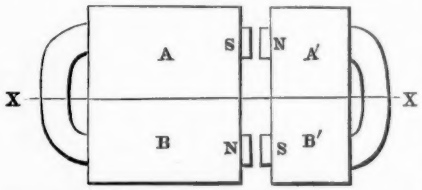
Weight of armature.	Deflection produced.
364 grams.	280
341	330
222	290
137	280
132	290
67	310

We are led to believe that the mass of the iron does not affect the results when it exceeds that of the stationary electro-magnet.

The induction currents resulting even from the employment of straight soft iron armatures which had been carefully deprived of residual magnetism are thus seen to be more than four times as strong as those obtained by merely slipping the induction coil on and off the limits of the electro-magnet; which is, practically, the method adopted in many later forms of the magneto-electric engine, particularly in that of the Gramm machine, in which different portions of a ring-shaped electro-magnet revolve toward and away from the poles of a horseshoe magnet. When electro-magnetic armatures are used the effects far surpass those obtained by non-magnetic soft iron straight armatures, as the preceding results show.

Professor Trowbridge suggests a magneto-electric engine of the following construction. The horseshoe armature is made to revolve about the line XX as an axis. By the preceding experiments it has been found that when a north and a south pole are opposed the induction currents flowing through B and A′ are in the same direction and those through B′ and A are also in one direction. By a suitable commutator the currents circulating through the coils on the stationary magnet can be sent through those on the armature, and vice versa. The residual magnetism in soft iron is sufficient to start the induced currents. Instead of one stationary electro-magnet it would probably be better to employ a number arranged about the axis XX. With projecting pieces of soft iron arranged upon the poles of the stationary magnets, the size of the horseshoe armature could be regulated to suit the varying conditions of speed.

2.



Experiments are now being made on this form of engine.

ART. XLII.—*Remarks on the Observations of the late Transit of Venus;* by SIMON NEWCOMB.

REPORTS more or less detailed having been received from all the parties engaged in observing the late Transit of Venus, we are in a position to form at least a rough estimate of the measure of success which has been attained. This estimate can, however, at present, only be preliminary, because the accuracy of the individual observations and methods cannot be assured except by a critical examination, discussion, and com-

parison of the observations, a work which will necessarily require much time for its accomplishment.

Among the causes which affected the prosecution of the observations, the weather occupies the most prominent place. The most striking feature of the weather at the late transit, so far as concerns the American stations, is the impartiality with which clouds have been distributed among the several stations. Notwithstanding that the utmost pains were taken to choose positions where the weather record for November and December was good, the prosecution of the observations was more or less interfered with by clouds at every one of the eight stations. On the other hand, there was not a station at which the operations totally failed. At the most unfortunate one, Chatham Island, six or eight photographs of the sun with Venus on its disc were secured. At two stations, Hobarttown and Chatham Island, no contacts at all were observed. The number of good photographs of the sun with Venus completely entered upon its disc is approximately as follows:

Northern Stations.

Wladivostok, Siberia,	13
Pekin, China,	90
Nagasaki, Japan,	60
Total,	163

Southern Stations.

Kerguelen Island,	26
Hobarttown, Tasmania,	39
Campbelltown, Tasmania,	55
Queenstown, New Zealand,	59
Chatham Island,	8
Total,	187

While the small number of these photographs is extremely disappointing, their distribution among so many stations is a great advantage, through the facilities thus afforded for detecting and eliminating any constant error peculiar to any particular station.

Besides the photographs here enumerated, a number of photographs of the indentation made by the planet while entering upon the limb of the sun were obtained at some stations.

Contact observations were obtained at the American stations as follows:

First External Contact.

Northern stations: Wladivostok, Pekin, Nagasaki. ?

Southern stations: Kerguelen, Queenstown.

The difference of time between the mean of the northern stations and Kerguelen, due to parallax, is thirteen minutes.

Compared with Queenstown, the difference is only four minutes. Allowing a probable error of eight seconds in the comparison of these observations, they would alone give a value of the solar parallax with the probable error 0″·090.

First Internal Contact.

This was observed at the three northern stations, but only at Queenstown in the south. The American observations alone will therefore give us no result entitled to weight. The southern region for the observation of this contact is that extending from Kerguelen Land to Mauritius and Rodriguez, and here very little success was met with by the parties of any nation in the observation in question. It may, however, have been successfully observed by the English at Rodriguez, and by the Germans at Kerguelen, from neither of whom the writer has seen definite statements on this point. On the other hand, it was successfully observed by the English parties at the Sandwich Islands, whose observations will be available for combination with those of Dr. Peters at Queenstown, and of other observers in Australia, even if no observations were made at Kerguelen and Rodriguez.

Second Internal Contact.

This was also observed at all three northern American stations, but at only a single southern one, namely, Campbelltown. The mean difference of time due to parallax is fifteen minutes. The favorable southern region for the observation of this contact was Australia, and the islands east and south of it, and the weather was exceptionally unfavorable in most of this region. Some success was obtained at and near Melbourne, and the German expedition in the Auckland Islands was also successful, but the English and French expeditions nearly all failed in this important observation.

Second External Contact.

This was observed at only a single one of the eight American stations, Pekin. It is, however, the least fitted of the four contacts to be accurately observed, and the failure to secure it is therefore the less to be regretted.

It is my opinion that the optical observations of contacts made by the observers of all nations will, by their combination, give a value of the solar parallax of which the probable error will lie between 0″·02 and 0″·03. I also think that the American photographs alone will give a result at least as accurate as this, and probably more so. A large remaining mass of material will be the heliometer measures made by the Germans and Russians as well as Lord Lindsay, various optical measurements made near the moments of internal contacts, and photo-

graphs in which Venus was partly on the sun. The combination of all these may be expected to give a result of equal weight with either of those already mentioned. I think, therefore, that we may look forward with considerable certainty to seeing the probable error from the combination of all the observations less than 0″·02, and, perhaps, not much more than 0″·01. At the same time, it is not to be disguised that there is a possibility of unforeseen perturbing causes being brought to light by a comparison of all the observations, which will upset all our *a priori* estimates of probable error.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Occurrence of Diphenyl in Coal Tar.*—Fittig communicates the results of an investigation made in the Tübingen laboratory by Buchner, upon a liquid hydrocarbon oil obtained as a by-product in the manufacture of anthracene. The portions of this especially examined were the less thoroughly known fractions boiling between 170° and 200°—i. e., between trimethylbenzol and naphthalin—and between 220° and 270°—or between naphthalin and acenaphtene. The first fraction by repeated distillation was almost entirely resolved into products boiling below 170° and others boiling above 200°; whence the conclusion that coal tar contains no considerable quantity of a hydrocarbon boiling between these limits. The second fraction gave a more satisfactory result. After several fractionings of five degrees, the portions distilling over between 242° and 263° solidified on cooling. By cooling these fractions considerably and subjecting them to pressure, a white crystalline mass was obtained, which remained solid at ordinary temperatures, and distilled completely between 245° and 250°. After two recrystallizations from alcohol, the hydrocarbon melted at 70°–71°, and exhibited all the properties of diphenyl.—*Ber. Berl. Chem. Ges.*, viii, 22, January, 1875.

G. F. B.

2. *Explosiveness of methyl nitrate.*—Methyl nitrate was discovered by Dumas and Peligot in 1835. In 1862, Carey Lea* showed that it could advantageously replace methyl iodide in most chemical reactions, especially in the preparation of the methyl bases. In 1864, as a consequence of this observation, Hugo Löwenstein applied it in the manufacture of the violets derived from rosaniline by substitution; and it has since come so extensively into use as almost to displace methyl iodide from the market. The most serious objection to its use is its explosiveness; a fact first pointed out by its discoverers, and since, unfortunately, realized on a large scale in the case of the death of the talented young chemist, E. T.

* This Journal, II, xxxiii, 86, 227, 1862.

Chapman, and in the more recent disastrous explosions both in Germany and France. GIRARD, employing it largely for the production of colors, has made some experiments with it, with a view to obviate this difficulty. He finds, for example, that methyl nitrate, like nitro-glycerin, detonates by a blow; a drop on blotting paper producing, when placed on an anvil and struck with a hammer, an explosion quite as violent as nitro-glycerin. When mixed with pulverulent or porous substances, such as precipitated silica or infusorial earth, it yields dynamites fully as effective as those made with nitro-glycerin. By admixture with other liquids, however, such as methyl, ethyl, or amyl alcohol, acetone, benzol or toluol, Girard finds that it is no longer explosive. One part of methyl nitrate diluted with two or three parts of either of the liquids above named, does not explode either on heating its vapor, or by a blow. In such solutions, therefore, it is best kept for use. —*Bull. Soc. Ch.*, II, xxiii, 63, Jan., 1875. G. F. B.

3. *On Pure Dextrin, prepared from Malt.*—BONDONNEAU describes the properties of dextrin prepared by the action of diastase on starch. A kilogram of dry starch, diffused in two liters of water, was treated in the cold with an extract of 250 grams of bruised malt in 500 grams of water; the whole being heated on the water bath to 75° until the starch had disappeared. The liquid was then carried to boiling to destroy the diastase, filtered through animal charcoal, and concentrated to 32°–33° Baumé. To free the dextrin in this solution from the glucose (dextrose) present, it was first reprecipitated five or six times with alcohol, then treated with a copper test made with cupric chloride and sodium hydrate; this latter treatment destroying the dextrose. As thus obtained, the dextrin showed no coloration with iodine, gave only feeble indications with the copper test (equivalent to 1·85 per cent dextrose) reduced gold chloride and ammonio-silver nitrate, gave an abundant precipitate with a solution of barium hydrate and with ammoniacal lead acetate, but none with lead sub-acetate. The dextrose present, the author believes to be produced by small quantities of non-coagulable albuminoids present, acting as ferments. By care and rapidity in operating, dextrin may be obtained devoid of reducing power. The rotatory power of the dextrin thus obtained is $\alpha j = 176°$ to the right; that produced by torrefaction being $\alpha j = 183°$.—*Bull. Soc. Ch.*, II, xxiii, 98, Feb., 1875. G. F. B.

4. *On the Identity of Liebermann's Cœrulignone with Reichenbach's Cedriret.*—HOFMANN has continued his investigations upon the less volatile constituents of beech-wood tar. In a previous paper he had shown that from these could be isolated a liquid boiling at 270°, possessing a phenol-like character, and yielding, when treated with potassium dichromate, the beautifully crystallized substance described by Liebermann under the name of coeruligenone, and also a magnificently crystallized compound in long yellow needles, dissolving in sulphuric acid with a carmine-red color. He has now been able by repeated fractioning and recrystalliza-

tion of the sodium salt, to isolate an oil boiling at 285°, which on oxidation is entirely converted into the yellow body, and which has the formula $C_{11}H_{16}O_3$, its bromine derivative being $C_{11}H_{14}Br_2O_3$. The yellow compound is a quinone-like body, having the composition $C_8H_8O_4$ and giving on reduction a hydro-compound $C_8H_{10}O_4$, crystallizing in white needles. Bromine gives a substitution derivative of the composition $C_8H_6Br_2O_4$. In regard to the body first named, to which Liebermann has given the name coerulignone, Hofmann concludes that it is identical with the substance long ago described by Reichenbach* under the name cedriret. The description originally given of it is quoted, and is full and complete. That a body possessed of properties so striking should have remained forgotten for thirty years, is exceedingly remarkable. In a note immediately following, Liebermann himself acknowledges the identity; though he was at first inclined to doubt it, owing to Reichenbach's having described it as a precipitate of fine *red* needles, and having obtained it from wood tar; whereas, his product was obtained from wood-vinegar and crystallized in dark steel-blue or violet needles. The production of this body by Hofmann from an oil derived from wood tar and evidently identical with Reichenbach's product, leaves no doubt of the identity.—*Ber. Berl. Chem. Ges.*, viii, 66, 69, January, 1875.

G. F. B.

5. *On a new Coloring matter, Eosin.*—A new coloring substance, introduced into commerce during the last summer under the name of Eosin, has been examined by HOFMANN. It has a beautiful red color, recalling that of rosaniline, but inclining more to garnet-red. The name eosin, by which it is known to the trade, unlike most similar names, is rational, being derived from Ἠώς, the red of the morning dawn. It appears as a brownish-red powder, showing here and there facets with metallic luster. It is soluble in water and in alcohol, and its solutions are strongly fluorescent. Upon examination, it was found to contain no nitrogen, and to evolve hydrogen bromide on heating, leaving a carbonaceous residue containing potassium bromide. Distilled with zinc dust it afforded benzol. Its aqueous solution treated with an acid, threw down a brick-red powder, which, recrystallized from glacial acetic acid, appeared as yellow prisms having the composition $C_{20}H_8Br_4O_5$; a formula confirmed by the analysis of the barium salt, $C_{20}H_6Br_4BaO_5$. From these data Hofmann concluded that eosin must belong to that most remarkable group of bodies with which Baeyer has enriched chemistry, being a tetrabrominated fluorescin; a derivative of a body which he obtained by fusing resorcin with phthalic oxide. To test this hypothesis, Hofmann treated the potassium compound with potassium hydrate, heated, decomposed by an acid, treated the filtrate with ether, and from the etherial solution obtained dibrom-resorcin in beautiful white needles. Eosin is therefore the phthalëin of dibrom-resorcin. Its synthesis was very easily accomplished by acting on an acetic solution of

* Berzelius Jahresbericht, xv, 408.

fluorescin—prepared from resorcin and phthalic acid by Baeyer's method—by bromine, and then diluting with water. The red precipitate thus obtained dissolved in alkaline solutions with the characteristic color of eosin, and when crystallized from glacial acetic acid, afforded the same product as that met with in commerce.

In a paper published subsequently, BAEYER states that eosin was first produced commercially at the Baden Aniline Works by Caro, and by him introduced to the trade under that name. He suggests the following experiment to show the relations of eosin: A portion of the coloring matter is agitated with water and sodium amalgam at a gentle heat. The solution is soon decolorized, the bromine being removed and colorless fluorescin produced. If now, water be added and a few drops of potassium permanganate solution, the fluorescin changes to fluorescëin and the liquid becomes bright green and almost opake, in reflected light.—*Ber. Berl. Chem. Ges.*, viii, 62, 146, Jan., Feb., 1875. G. F. B.

6. *On the Structural Formula of Hydroxylamine.*—The body NH_3O, discovered originally by LOSSEN, and to which he gave the name hydroxylamine, possesses great theoretic interest. It may be regarded as ammonia in which hydroxyl replaces an atom of hydrogen; as a direct compound of the radicals amidogen and hydroxyl; or as a compound in which an atom of nitrogen has two of its units of attraction saturated by two hydrogen atoms while the third is united to one of the bonds of an oxygen atom, the other being saturated by hydrogen; thus $H-\overset{H}{\underset{|}{N}}-O-H$. It would seem as if there could be little question upon the rational constitution of so simple a body. The above rational formula rests, first, upon the method of its preparation and second upon its ammonia-like properties. It is prepared by the reduction of nitric acid, precisely as nitro-methane is reduced to methylamine or nitrobenzoic acid to amidobenzoic acid; the radical NO_2 in all these cases being changed to NH_2. Hence from $NO_2.OH$ comes very readily $NH_2.OH$. Again, the ammonia-like structure of hydroxylamine is shown by the fact that it unites with acids to form salts without the formation of water. The structure above given, however, involves the assumption that two of the three hydrogen atoms, being similarly situated and combined, should exhibit the same behavior; while the third, being differently united, should behave differently. LOSSEN has undertaken to test this assumption experimentally. By an easy replacement of the hydrogen atoms in hydroxylamine by benzoyl, benzhydroxamic and di-benzhydroxamic acids, and tribenzhydroxylamine, are successively produced. Entirely analogous compounds are produced by anisyl. Calling the hydrogen atoms one, two, three, in this order $N\overset{1}{H}\overset{2}{H}\overset{3}{O}H$, we have, when both radicals replace hydrogen, benzanishydroxamic acid $N(C_7\overset{1}{H}_5O)(C_8\overset{2}{H}_7O_2)\overset{3}{O}H$ and anisbenz-

hydroxamic acid $N(C_8\overset{1}{H}_7O_2)(C_7\overset{2}{H}_5O)O\overset{3}{H}$, with two replacements; and dibenzanishydroxylamine $N(C_7\overset{1}{H}_5O)(C_7\overset{2}{H}_5O)O(C_8\overset{3}{H}_7O_2)$, benzanisbenzhydroxylamine $N(C_7\overset{1}{H}_5C)(C_8\overset{2}{H}_7O_2)O(C_7\overset{3}{H}_5O)$, and anisdibenzhydroxylamine $N(C_8\overset{1}{H}_7O_2)(C_7\overset{2}{H}_5O)O(C_7\overset{3}{H}_5O)$, when three atoms are thus exchanged. Now if hydrogen atoms 1 and 2 in hydroxylamine are precise equivalents, the first two of the above named five compounds are identical; if not, they are only isomeric. If hydrogen atoms 2 and 3 are equivalents, then the third and fourth of the above compounds are identical; but they are only isomers, if they are not. Lastly, if hydrogen atoms 1 and 3 are equivalent to each other, the third and fifth of these compounds must be the same; but if these atoms are not precisely identical in function, the compounds must be isomers. The author has proved the most important point, that benzanishydroxamic and anisbenzhydroxamic acids are not identical, but are isomeric. The former fuses at 133° to 134°, the latter at 147° to 148°, and their chemical reactions as given are quite different. It seems clear therefore that hydrogen atoms 1 and 2 are not the precise equivalents of each other, and that there are at least two kinds of such atoms in hydroxylamine. Lossen assigns therefore to dibenz-

hydroxamic acid the formula $C_7H_5O-\overset{H}{\underset{|}{N}}-O-C_7H_5O$ and to

dianishydroxamic acid that of $C_8H_7O_2-\overset{H}{\underset{|}{N}}-O-C_8H_7O_2$. The author promises further researches to fix the position of the replacing radical in the monohydroxamic acids.—*Liebig's Ann.*, clxxv, 271, Jan., 1875. G. F. B.

7. *Influence of Pressure on Combustion.*—M. L. Cailletet has studied the effect of a pressure of 30 to 35 atmospheres on the luminous, calorific and chemical rays, emitted by a burning body. The air was compressed by pumps in which the pistons were fixed and the cylinders movable, a layer of water or glycerine at the same time cooling the gases so as to protect the packing from the heat, and preventing leakage. The reservoir consisted of a hollow cylinder with four apertures; the first admitted the gas, the second allowed it to escape, the third admitted the manometer-tube, and the fourth was closed by a thick glass plate to allow of observation of the interior. The latter had a diameter of 10 cms. and a capacity of about 4 liters. Placing a lamp in this space, the brightness increased with the pressure of the air. The base of the flame, which under the ordinary pressure is blue and transparent, became white and very bright; but soon the appearance changed and thick clouds of smoke circulated through the apparatus and escaped by the stopcock closing the outlet. The flame seen through this smoke is reddish and the wick is found to be charred and much soot deposited, doubtless owing to the dissociation of

the gases containing carbon. The heat increases but not enough to burn an iron wire heated to redness in the common flame.

The brightness of the flame of burning phosphorus does not seem to increase, but that of sulphur is brighter and yellowish-red on the borders.

Potassium burns with a very bright violet flame. The combustion in a charcoal furnace did not seem more rapid under 25 atmospheres than at the usual pressure. An alcohol lamp with a wick formed of a single thread, and giving in the open air a scarcely visible flame, rapidly increased in brightness with the pressure. At 20 atmospheres, the flame is white and bright as that of an oil-lamp. Its spectrum is continuous and more extended than at ordinary pressures; the ray *D* is alone visible, apparently enlarged. Bisulphide of carbon also burns more brightly than usual. Neither it nor sulphur gives a perceptible quantity of sulphuric acid.

The chemical rays, as well as those of light and heat, seem to have an increased activity. A number of flattened tubes containing phosphorescent substances were exposed to the rays of these flames and shone with a much brighter light with the increased pressure.—*Comptes Rendus*, lxxx, 487. E. C. P.

8. *Magnetism.*—M. Bouty has studied the laws of magnetic action by means of a new and simple device for measuring magnetic moments. A small magnet attached to a mirror is fastened to the lower end of a rod of sealing wax and suspended by a filament of silk. In the upper part of the rod a small glass tube is inserted at right angles to the magnet. If now a magnet is inserted in the tube, the system will assume a position of equilibrium under the action of the two magnets, from which their relative magnetic moment is readily determined. The angular deflection is measured by means of a telescope and scale. The lower magnet has a length of 6 cms. and a diameter of ·2 mms; the tube a length of 2 cms. and a diameter of ·2 mms. By this arrangement the moment of magnets could be determined whose length was but 2 mms. and their diameter ·2 mms. With this apparatus the magnetization of a bar was measured when it was inserted a number of times into a helix, and was found to be well represented by the empirical formula $Y=A-\frac{B}{X}$, in which Y is the moment and X the number of insertions.

The effect of breaking a needle was next studied. The needle was heated to redness and plunged instantly into water, and the middle portion, about 150 mms. in length, alone employed. Green has deduced a formula for the magnetic moment of saturated bars of various lengths. But the primitive needle possesses in every point a higher degree of magnetization than corresponds to the saturation of the fragment which belongs to it after breaking. Two instruments are employed, one of great delicacy, for the short fragments, a second less sensitive for the longer pieces. The agreement of observation with theory is all that could be

desired until the length becomes small compared with the diameter. The law for changes in the diameter and the effect of a fracture parallel to the axis were also studied. Finally, on the ground of the peculiar facts examined in this memoir, as well as the whole of the known facts, he concludes that the present theories of magnetism are insufficient to explain the peculiarities of the temporary magnetization of steel, and suggests that in regard to the magnetic properties of its elements this substance must be considered a heterogeneous mass.—*Phil. Mag.*, xlix, 81, 186. E. C. P.

9. *Frictional Electricity.*—M. ROSSETTI has made a careful study of the current developed by a Holtz machine and shown that it follows the laws of a galvanic battery. The machine was turned by a weight, and the work done measured when charged and discharged. The current was determined by a galvanometer and the resistance by four long fine tubes filled with distilled water. The current is nearly proportional to the speed, but increases a little more rapidly than the latter. The ratio of the two alters with the amount of moisture in the air, so that to produce a given current the machine must be driven faster in wet weather, although the work required is less than when the air is dry. The economy, therefore, is greater on wet than on dry days. A Holtz machine resembles a galvanic battery, having an electromotive force and interior resistance which are constant as long as the velocity and moisture are constant. The electromotive force is invariable for a given degree of moisture whatever the velocity, while with a given velocity it diminishes as the moisture increases. The interior resistance on the other hand is independent of the moisture and diminishes more rapidly than the velocity increases. In the actual instrument employed, when the moisture was ·69 the electromotive force equalled 41,000 volts, while with the moisture ·35 it equaled 57,000 volts. The resistance with a velocity of eight turns per second was 540,000,000 ohms, and with a velocity of two turns 2,680,000,000 ohms. The current follows the law of Ohm, consequently if very large exterior resistances are employed, the strength of the current gives the mechanical equivalent of heat. The mean of seventeen experiments gave as a result the number 428, which agrees very closely with the commonly received value.—*Ann. de Chim. et Phys.*, iv, 214. E. C. P.

10. *Chemical Sub-section in the American Association for the Advancement of Science.*—This sub-section of the American Association was organized at the Hartford meeting in August last. It is called the "Sub-section of Chemistry, Chemical Physics, Chemical Technology, Mineralogy and Metallurgy," and all persons interested in applied as well as in pure chemistry will be welcome at Detroit, where the next session is to be held, in August of this year. We make this statement very willingly at the request of Prof. F. W. Clarke, of Cincinnati University, who is the secretary of this section, and who is making active exertions to secure a large gathering of chemists on that occasion. Prof. S. W. Johnson, of Yale College, is chairman-elect of this section.

II. Geology and Natural History.

1. *Supplement to the Article on Dr. Koch's evidence with regard to the cotemporaneity of Man and the Mastodon; by the Author.*—Since the article on pages 335 to 346 was printed, I have come across another of Dr. Koch's pamphlets. It is a "second edition" of the New York pamphlet of 1845. In the main it is the same with the earlier one of that year. The most important difference is in the first half of the title page, which reads as follows:

"Description of the Hydrarchos Harlani (Koch). (The name Sillimanii is changed to Harlani, by the particular desire of Professor Silliman.) A gigantic Fossil Reptile, lately discovered by the author, in the State of Alabama, March, 1845."

A *second* difference is in the appended matter of nearly 10 pages, which extends the pamphlet to 24 pages. This matter consists of (1) an extravagant article from "The New York Dissector;" (2) the article from the "New York Evangelist" about the Hydrarchos and Leviathan, alluded to on page 344, as occupying the inside pages of the pamphlet of 1853; and (3) a puff from the "New York Morning News."

A *third* novelty is a large wood-cut of the "*Hydrarchos Harlani*," covering the last page of the cover. The body of the pamphlet contains only some verbal changes.

These New York pamphlets of 1845 contain one significant discovery of Dr. Koch's, made during his "geological tour," which is worth citing. He says: When at Golconda, Illinois, "I discovered a large deposit of old red Sandstone or Devonian system, in which I found a great variety of non-described fossil fish of most wonderful forms, the spiral columns of many of them bearing a striking resemblance to a screw, so that they are called by the inhabitants of the country *petrified screws*."

The Doctor's "spiral columns" of "fossil fish" are the common Bryozoan corals of the genus *Archimedipora*, found there, and elsewhere, only in Subcarboniferous rocks.

2. *Cold of the Glacial and other Geological epochs.*—The idea that a high-latitude elevation making a partial barrier across the shallower part of the Atlantic Ocean from Scandinavia to Greenland, would produce a change of temperature in the North Atlantic, is brought out by Mr. Prestwitch in his Presidential Address before the Geological Society of London, in 1871, to account for changes in the life of the ocean, during the latter part and close of the Cretaceous period; and the principle is recognized by Dr. W. B. Carpenter in his elaborate paper on Ocean Currents in connection with his Researches on board the "Shearwater" in 1871, read before the Royal Society in June, 1872, and published in No. 138 of the Society's Proceedings, xx, 535–644. J. D. D.

3. *Geological Survey of Wisconsin.*—The present geological survey of Wisconsin was organized in the spring of 1873, with Dr. I. A. Lapham as chief geologist, and Professor R. D. Irving,

of the State University, Professor T. C. CHAMBERLIN of Beloit College, and Mr. MOSES STRONG, Mining Engineer, as assistant geolgists; and Professor W. W. DANIELS, of the State University, as chemist. The appropriation was $13,000 annually for four years.

The name of the Chief Geologist was a guarantee that the work would be faithful and exact.

Two seasons have been occupied in office and field work. During the first season there were three parties in the field, and during the second, four, a special contract having been made for a survey, during the latter season, of the Menominee River Huronian region, with Major T. B. Brooks, of the Michigan Survey, the work being really but an extension across the State line of his previous labors in Michigan. By the close of the last season one-third of the State had been examined in detail, and very many interesting facts developed. Reports have been made sufficient to fill a large quarto volume, accompanied by hundreds of illustrations and over a hundred detailed maps. These maps embrace all the results possible to place upon them; it having been the aim of the corps to put as much of the work as possible in this permanent form. They are complete for all portions of the State examined, and include geological, topographical, agricultural and other maps, accompanied by large general sections, all drawn on a scale of two inches to the mile.

The entire lead region has been topograpically surveyed and mapped with contour lines at a distance of fifty feet vertical, as recommended by Whitney in his report on the same region. Careful determinations of dips were made at the same time, so that the exact position of the mining ground—confined to certain strata—is made known at each locality.

Northern Wisconsin, bordering on Lake Superior, has been examined in detail, and some interesting facts bearing on the ages of the Lake Superior sandstone and of the copper rocks ascertained. The main work in northern Wisconsin consisted in an investigation of the Huronian rocks and ores of the Penokie Iron Range of Ashland County. The range is thirty miles in length in Wisconsin and about a mile in width at base. Several streams break through it from the southward, affording magnificent sections of its rocks, and on its flanks the siliceous ores that form its mass everywhere outcrop in precipitous exposures. These outcrops have been measured and the ore sampled and analyzed. The report on this range alone would form a volume of considerable size, with some scores of illustrations.

Eastern Wisconsin has been nearly or entirely surveyed by Prof. Chamberlin's party. He has been able to divide the Nia ara limestone into several subordinate formations. He has also obtained many new and interesting facts bearing on the drift phenomena of a region most remarkable for its glaciated surfaces, giant kettles, boulder clays and moraine heaps. He has also prepared a series of soil and timber maps of this region, and has collected no less than 14,000 fossils, many of them new forms.

Central Wisconsin has been examined in detail by Professor Irving, where he has made observations on the Lower Silurian of the Four Lake country; the Archæan quartzyte range of Sauk and Columbia Counties; the extensive Potsdam sandstone region of the center of the State, with its remarkable castellated outliers of sandstone, and numerous Archæan islands; the boundary between the Archæan and Potsdam; the rocks of the main Archæan body along the valleys of the Wisconsin, Yellow, and Black Rivers; and on the drift phenomena of the entire region, which are especially interesting because the area is just on the edge of the driftless region of the western half of the State.

While the members of the corps were just now expecting authority from the legislature for the printing of these reports, they were greeted, we learn, by the announcement that the governor had appointed a new chief geologist, and one whose sole recommendation for the position was political services, no one having ever heard of him before as acquainted with geology or any other science. It appeared that Dr. Lapham had been appointed under the law subject to the confirmation of the senate at its next session. At that time a new administration had come in and Dr. Lapham's name was never sent in, though he continued to perform his duties, and to be recognized by the State officials. This fact was taken advantage of to oust him, the appointment being defended in the senate by parties from the northern portion of the State, who had got the idea that the reports on the mineral regions of that section were not as favorable as interested parties desired. The whole thing was a total surprise to Dr. Lapham and other members of the corps, so that there was no time for any opposition on their part, or that of other friends of the survey and of good honest scientific work.

A great wrong has been done to Dr. Lapham, and a greater to the State. But we cannot believe that the State of Wisconsin will be satisfied to thus stultify itself before the world by sustaining the appointment to a scientific position of one who confessedly knows nothing of its duties.

4. *Geological Survey of Alabama. Report of Progress for* 1874; by EUGENE A. SMITH, Ph.D., State Geologist. 140 pp. 8vo. Montgomery, Alabama, 1875.—Prof. Smith, after a history of the Geological Survey of the State hitherto undertaken, gives in a brief and systematic form the results of his geological work carried on during the past year. His labors were confined mainly to the portions of the State occupied by crystalline rocks, and especially to Chilton, Talladega, Cleburne, Randolph, Clay, Coosa, Tallapoosa, Chambers, Lee, and Elmore Counties. The rocks, and the mines or valuable minerals they contain, are described with care. The crystalline rocks include granites, gneiss, hornblendic rocks, mica schist, hydromica slate, chlorite slate; and also hypersthenyte or noryte, which occurs near Columbus; with crystalline limestones, which are partly dolomitic. Among the materials of economical importance occurring in these counties

are included marbles; soapstone at many localities in Clay, Tallapoosa, Chambers and other counties; white porcelain clay; asbestus; mica; corundum, in Tallapoosa County; graphite; gold; copper, in Wood's Mine in Cleburne County; iron ores, which are associated usually with the hornblendic rocks. The Report closes with chemical analyses of various iron ores, coals and limestones.

5. *Geological Survey of New Jersey. Annual Report of the State Geologist*, Prof. GEORGE H. COOK, for the year 1874. 116 pp. 8vo. Trenton, N. J., 1874.—Prof. Cook gives, in his Report for 1874, new information on the remarkable series of Archæan iron mines in New Jersey, and also facts respecting mines of limonite, copper, zinc, and the quarryings of pottery clay, etc. He states that 700 to 1000 tons of metallic zinc are now made annually from New Jersey ores, 850 tons from Pennsylvania ores, and more than 3000 tons from Western ores. With regard to the white clays of New Jersey, he remarks that 265,000 tons of fire clay are annually dug in Middlesex County, about Woodbridge, Perth Amboy and South Amboy, and sold at an average price of $3.50 per ton. Besides, there are 20,000 tons of stoneware clay dug at South Amboy, which averages $4 per ton, and is shipped to all parts of the United States.

Prof. Cook states that the *geological position of the clay deposits is in the Cretaceous formation*, and that the stratum constitutes its lowest member. They occur in a belt of country stretching across the State from the northeast, on Staten Island Sound and Raritan Bay, to the southwest, ending on the Delaware in Gloucester County. Its northwest edge adjoins the Triassic red sandstone from Woodbridge to near Trenton, where for five or six miles it borders on the gneiss; thence to the southwest end, it follows along or near the Delaware River.

6. *Preliminary Report of the State Geologist of Oregon;* Rev. THOMAS CONDON. 22 pp. 8vo. Salem, Oregon. 1874.—Mr. Condon, who has in past years done much in the collection of the mammalian and other fossils of the interior of Oregon, was appointed State Geologist in October, 1872, but upon a salary of only $1000 per annum, and under the idea of his devoting but part of his time to the object. This preliminary report gives an interesting review of the topography of the State, with important facts respecting the great lake basins of the Tertiary, and the relations of the Tertiary sandstones containing silicified and coaly trunks of trees, to the overlying igneous rocks in the line of the Cascade Range. He speaks of the latter rocks as having a thickness exceeding 4000 feet, and as consisting of porphyry below, trachyte over the porphyry, and heavy dark basalt above.

7. *Prof. O. Heer's Arctic Flora.*—The first two volumes of Prof. Heer's Arctic Flora are as widely known as the name of the celebrated author. A third volume has been published recently*

* By Wurtzer & Co., of Zurich.

from materials collected by the Swedish Polar expeditions under the direction of Prof. Nordenskiöld. This volume admirably completes the work, by the superior character of its execution and by the interesting facts which it exposes in regard to the geological floras of the Arctic and Polar regions. It contains, 1st, a paper on the Carboniferous flora of the Arctic zone (eleven pages and six plates); 2d, the Cretaceous flora of the Arctic zone (one hundred and forty pages with thirty-eight plates); 3d, an appendix to the Miocene flora of Greenland (three pages and five plates); and 4th, a general revision of the Miocene flora of the arctic zone (twenty-four pages).

The most important part of this publication is that on the Cretaceous floras, not merely for the reason that the vegetation of the Cretaceous land was till now scarcely known, but because its exposition brings out documents related to a number of interesting problems which are masterly presented and discussed by the author. This part has a peculiar interest for the naturalists of this country, on account of the discovery in Nebraska and Kansas of a terrestrial formation closely related in time to that of the Upper Cretaceous of Greenland, in which a large number of fossil plants have been discovered and recently described by Lesquereux in a volume published by the Department of the Interior, as noticed on page 227. The fossil plants of Greenland are from two divisions of the Cretaceous; the lower one, which, from the character of its flora, is intimately allied to the Upper Jurassic, the flora being mostly composed of Ferns, Conifers, Cycadeæ, with a few monocotyledonous and a single dicotyledonous species, representing apparently a kind of *Populus*. The Upper Cretaceous division has in its flora, with a large proportion of Ferns and Conifers, two species of Cycas only, and thirty-four dicotyledonous species out of sixty-two which compose the whole flora. Among these there are species of the Genera *Myrica*, *Ficus*, *Sassafras* (one species), *Andromeda*, *Diospyros*, *Magnolia*, etc., which are also represented in the Cretaceous of Nebraska, either by identical or related forms. This indicates an evident relation, which, however, is far less marked than would be expected between two groups of plants from formations where synchronism is probable. For among the one hundred and thirty species described from the Dakota group of Nebraska, one hundred and thirteen are dicotyledonous and many of the genera, *Liquidambar*, *Salix*, *Betula*, *Alnus*, *Quercus*, *Fagus*, *Platanus*, *Laurus*, *Liriodendron*, *Menispermum*, are not represented in the flora of Greenland. In Nebraska also there is a preponderance of species referable to *Sassafras*, while from Greenland one leaf only is described as of this genus. As all these genera are now widely distributed in the North American flora, this preponderance of American types leads us to refer the origin of our present flora to the American Cretaceous.

An intermediate division, that of the Middle Cretaceous, is represented in the volume of Heer by a small number of plants

from Spitzbergen, in all sixteen species of Ferns and Conifers with only one *Equisetum*.

8. *On Serpentine Pseudomorphs after Monticellite, a Lime-magnesia Chrysolite;* by G. VOM RATH. (Monatsb. k. Akad. d. Wiss., Berlin, Nov. 19, 1874.)—The pseudomorphs described by Vom Rath are from the Pesmeda Alp, on Mt. Monzoni in the Tyrol. The syenyte, dioryte and "augitic greenstone," which constitute the Monzoni peak, come up through limestone [of the Triassic formation] which is in part crystalline; and this limestone contains many crystallized silicates near its junction with the other rocks, viz., fassaite, vesuvianite, gehlenite, garnet, spinel, etc. In a high ridge adjoining the Pesmeda Alp, at a height of about 2500 yards, the limestone, near its contact with "augitic greenstone," affords crystals of the form of monticellite, along with others of anorthite, garnet and spinel. The monticellite crystals, some of which are two inches long, are all changed to serpentine. They occur mixed with fassaite, and with a blackish green spinel which is also in part serpentine. The color of the pseudomorphs is light brown, yellowish and occasionally white. The crystals within are irregular in texture and color, as is well represented on a plate showing magnified sections. Vom Rath gives several excellent figures of the crystals. Unaltered monticellite has not been found at the locality, but it occurs massive (Breithaupt's batrachite) to the west of Pesmeda and to the southeast of Mt. Monzoni, near the junction of the limestone and syenyte. This massive kind is externally altered.

Vom Rath also states that the locality of serpentine-pseudomorphs affords others of *monticellite altered to fassaite.* The crystals are an inch and less in size. They have sometimes a nucleus of serpentine or calcite. The fassaite pseudomorphism in all cases preceded the serpentine.

9. *On the conversion of an argillaceous rock to Serpentine;* by A. D'ACHIARDI. (Bolletino R. Com. Geol. d'Italia, 1874, p. 336.)—In Montajone, Italy, south of San Miniato, there is connected with the Upper Tertiary an unconsolidated earthy mass, greenish white in color, and partly halloysite-like in composition (B in the figure below), which is intersected by numerous dolomitic (*d, d*)

A, clayey deposit containing nodules or fragments of indurated clay; B, the part of same deposit that has become halloysitic and in which the nodules consist of serpentine surrounded by dolomite; C, Upper Tertiary; *s, s*, steatitic veins; *d, d*, dolomitic veins.

and steatitic (*s, s*) veins, and contains besides isolated nodules of a fine green, compact serpentine, more or less translucent, which are often coated with dolomite. The bed or mass followed to the northwest loses its steatitic and dolomitic veins, and graduates into

a rough, dark clay bed (A), containing nodules that are like the serpentine nodules in form, size and position, but which consist of indurated clay, reddish gray or grayish yellow in color. From the unaltered clayey nodules there is a gradual passage, through others partly altered, to those consisting wholly of serpentine. D'Achiardi concludes that the serpentine nodules were produced through the alterations of the clay nodules. He refers their formation to the action of hot magnesian waters on a hydrated aluminous silicate, and the replacement thereby of the alumina by magnesia. The halloysite-like material he regards as containing the alumina which was removed from the nodules in the process of alteration.

10. *On the formation of Mountains and the hypothesis of a liquid substratum beneath the Earth's crust;* by Rev. O. FISHER, (Proc. Cambridge Phil. Soc., Feb. 22.)—This paper was a sequel to one read in Dec., 1873, in which it had been shown that, upon the supposition that the inequalities of the earth's surface have been formed by contraction of its volume through cooling, they are too great to be so accounted for if the earth has cooled as a *solid* body. In the present communication it was therefore assumed that there is a *liquid* layer beneath the cooled crust; and an approximate calculation was made of the form which the corrugations of a flexible crust would take if so supported. It was shown that their lower surface would consist of a series of equal circular arcs arranged in a festoon-like manner, and having a radius $2\frac{\rho}{\sigma}c$, where ρ, σ are the densities of the crust and liquid respectively, and c the thickness of the crust. It was argued that the consequences of this form of corrugation agree fairly well with some of the phenomena of mountain elevation, but that it does not suffice to explain the ocean-basins and the continental plateaux.—*Nature*, March 18.

11. *Botany of the Island of Amsterdam.*—It is a curious fact that the little island of Amsterdam, in the South Indian Ocean, is known to be covered with trees, whilst the island of St. Paul's, only fifty miles to the south, is destitute of even a shrub. Botanists have long been anxious to determine the character of the Amsterdam forest, but the difficulty of effecting a landing on the island has generally prevented the collection of specimens. In the last part of the *Journal of the Linnean Society*, Dr. Hooker announces that at length he has received the desired specimens, these having been collected by Commodore Goodenough, who states that they represent the only species of tree growing on the island. Dr. Hooker identifies this with the *Phylica arborea* of Thouars, a tree which, strangely enough, is found in the remote Island of Tristan d'Acunha. It is a curious problem for those who study insular Floras to suggest how the same plant can have established itself on these two little specks of land, separated from each other by about five thousand miles of ocean.—*Athenæum*, March 6.

12. *Amphioxus lanceolatus.*—Prof. Huxley has shown, in a paper read before the Royal Society (Ann. Mag. Nat. Hist., IV, xv, 225),

that the anomalous *Amphioxus*, which Hæckel refused to admit into the class of Fishes, is closely related in some important characters to the Marsipobranch fishes. In the mouth with its tentacles, and in some other respects, *Amphioxus* is much like *Ammocœtes* (the young of *Petromyzon*). "The several pairs of nerves in *Amphioxus* which leave the cerebro-spinal axis between those which answer to the *portio dura*, and the optic nerve are represented by the third, fourth, fifth and sixth pairs of cranial nerves of the higher Vertebrates. The cranium of the latter is represented by those segments of the body of *Amphioxus* which lie in front of the fifteenth, counting from before backward, and their cranial nerves by the corresponding anterior pairs of nerves. No auditory apparatus was distinguished; but "in all other respects *Amphioxus* conforms to the Vertebrate type;" and, considering its resemblance to the early stages of Petromyzon (described by Schultze), there is no reason for removing it from the class *Pisces*. On account of its permanently segmented skull and its many other peculiarities, Prof. Huxley regards it as the type of a primary division which he names *Entomocrania*, other fishes being *Holocrania*.

13. *Zoological Station at Naples.*—Dr. Anton Dohrn has issued a Catalogue* of the Library of the Zoological station at Naples. Nearly one half of the volumes belong to Dr. Dohrn, and formed his private library at the time he established the zoological station; the other half consists of works presented either by the publishers or by the authors to the station. As a library of embryological and anatomical works on marine animals, it forms an admirable nucleus for the building up of a great zoological library. It only needs the continued interest which has been shown by all working naturalists to supply the station with everything published needed to carry on investigations in every department of zoology. Dr. Dohrn is anxious to secure the co-operation of American naturalists and hopes that they will remember the zoological station in the distribution of their papers. A. A.

14. *Birds of the Northwest:* a hand-book of the Ornithology of the Region drained by the Missouri River and its tributaries; by Elliott Coues. 8vo, 791 pages.—This volume forms part of the miscellaneous publications of the United States Geological survey of the Territories, under Dr. Hayden. It includes quite full synonyms of all the species and varieties belonging to the region, with many valuable descriptions of the habits, geographical distribution and variations of the species. The families *Laridæ*, *Colymbidæ*, and *Podicipidæ* are treated monographically, all the North American species being fully described. V.

15. *Geographical Distribution of Animals.*—Mr. A. R. Wallace has in the press a work on this subject, which is to be illustrated with elaborate maps, and woodcuts of animals. It will be published by Messrs. Macmillan.—*Athenæum*, Feb. 27.

* Die Bibliothek der zoologischen Station zu Neapel, Verzeichniss der daselbst bis zum Ende des Jahres 1873 vorhandenen Bücher. Leipzig. 8vo., pp. iv, 791. 1874. Wilhelm Engelmann.

III. Astronomy.

1. *On the Total Eclipse of the Sun of April 16th, as observed by Mr. Stone at Klipfontein in Namaqualand, South Africa,* 55 miles from the sea and 20 miles from the central line of shadow.—The general results which Mr. Stone considers he has obtained from the observations are summarized as follow: "1. A confirmation of Young's observations of the general, or nearly general, reversion of Fraunhofer's lines in the spectrum of the corona near the photosphere. 2. A spectroscopic examination of the outer corona, in contra-distinction to the inner corona, carried to the extent of rather more than a degree from the sun's center, which has proved that the spectrum of the outer corona consists of a linear spectrum of one bright line, either exclusively or sensibly, whose wave-length is 5,312, and of an ordinary sunlight spectrum with absorption lines. The spectrum of the outer corona has been shown to fade gradually away as the extreme visible limit of the corona is approached, and not to disappear sharply as if the extreme limit of the corona had been reached. 3. This spectroscopic examination of the outer corona, combined with the unchanged character of its principal features as seen at Namaqualand, Griqualand, and Basutoland, at intervals of absolute time extending to 10^m, and at distances of more than 500 miles, proves, I venture to think, the solar origin and cosmical character of the outer corona. The want of coincidence in the positions of the general extensions of the inner corona with the main branches of the outer corona is an additional argument against the atmospheric origin of the outer corona. 4. A comparison of the drawing by Mr. Hall, made at Namaqualand, and the photographs obtained in 1869 and 1871 shows the permanent character of the contraction of the inner corona in a direction parallel to, or nearly parallel to, the sun's axis of rotation. The strongly marked character of the contraction of the outer corona in the same direction, as seen in the eclipse of 1874, may not improbably ultimately lead to a similar inference in the case of the outer corona also."—*Monthly Notices*, February, 1875.

2. *Schiaparelli's Observations of Comet III* 1862.—The careful observations made by Professor Schiaparelli of Comet III 1862, which, among the large comets, possesses a peculiar interest from its connection with the August meteors (the *Perseids*), have been lately published, the delay having been occasioned by the difficulty of reproducing faithfully the original drawings, which have now been drawn on stone by Signor Tempel of the Milan Observatory. Prof. Schiaparelli, in his *Memoir*, first gives the original observations, and then discusses them under various heads. The apparent brightness of the coma increased from 6 mag. on July 24, to 1·7 mag. on August 31, and the intrinsic brightness, calculated by the usual formula, $\frac{1}{r^2\Delta^2}$, also increased from 0·210 to 1·017 within the

same period, but not uniformly; increasing for ten days, then remaining stationary for a like period, after which there was again an increase for ten days, followed by a second stationary period; these changes being unaccompanied by any marked variation in the size of the head. Corresponding to the increase in brightness of the head, there was a marked decrease in brightness of the nucleus, which could not, Signor Schiaparelli considers, have exceeded 350 miles in diameter when nearest to us, from which he concludes that its density must then have been considerable, as it alone contained the materials for the coma and tail in all succeeding apparitions of this comet. The appearance of the luminous jets is then discussed, and is connected with a general want of symmetry in the head of the comet, the left side of which (supposing the tail to be below the head) was more developed, so that the comet resembled a stick with a knob on one side. The most remarkable feature in this comet was the large inclination of the tails (of which there were three on August 21) to the plane of the orbit, a fact which was established by the circumstance that the apparent angle between the tail and the prolongation of the radius vector did not change sensibly on the passage of the earth through the plane of the orbit on August 10. The lateral deviation of the tail, which was very considerable, Prof. Schiaparelli refers to an explosive force from the left of the nucleus, from the effect of which the particles projected from the head would, under the action of a repulsive force from the sun, describe parabolas, having the head as vertex and the radius vector as axis, the tail being curved back till, near its extremity, it became parallel to the radius vector. This would require the nucleus (which was apparently unsymmetrical) to preserve a nearly constant direction in space, which the author considers might result either from a polar force residing in the sun, or from the absence of rotation of the nucleus. Another imporant conclusion drawn by Signor Schiaparelli is that the particles of the tail exercise a mutual repulsion on each other, causing the anterior boundary to curve forward till it cuts the prolongation of the radius vector, the axis of the parabolas which would be described by the particles of the tail if only under the sun's repulsive force.—*Monthly Notices*, February, 1875.

3. *The Gold Medal of the Astronomical Society.*—The Council have awarded the gold medal to Prof. D'Arrest, for his work entitled "Siderum Nebulosorum Observationes Havnienses institutæ in Specula Universitatis per Tubum Sedecimpedalem Merzianum ab Anno 1861 ad Annum 1867," and his other astronomical works. The President will explain to the meeting the grounds of this award after the Annual Report.—*Monthly Notices*, February, 1875.

4. *Fall of a meteor in Iowa.*—A meteor fell in Iowa on the night of Feb. 12th with loud detonations. The principal portion of the fragments from the stone have been secured for the Iowa State University by Prof. Leonard.

IV. Miscellaneous Scientific Intelligence.

1. *Anderson School of Natural History.*—The experience of the past two years has shown that it will be impossible to carry on the School of Natural History at Penikese on the same terms as formerly. At the close of the last session the Trustees had exhausted their resources. They propose to charge a fee of fifty dollars for the season of 1875, and to carry on the school during the coming summer if a sufficient number of applications are received in time to make the necessary arrangements. Even with the full complement of students, there will be a considerable deficit (as was the case last year) to be met by the friends of the school; the position of Penikese necessitating many expenses which need not be incurred in a more favored locality. Applications should be sent at once to the Director at Cambridge, Mass.; preference will be given to teachers and to those who intend becoming teachers. Alexander Agassiz, *Director.*

2. *Note on a supposed change in the Climate of Scotland;* by A. Buchan.—Mr. Buchan concludes a paper in *Nature* of February 25, as follows: "The general result of the inquiry then is, that though large annual fluctuations of temperature have occurred, yet the warm and the old cycles, extending over longer or shorter periods, are so distributed over these long intervals as to give no indication that there has been any tendency toward a steady increase or decrease in the temperature, or that any permanent change has taken place in the climate of Scotland. And since the same remark applies with equal force to the observations of the separate months, it follows that meteorological records give no countenance to the idea of a permanent change having occurred in the climate of Scotland either as regards summer heat or winter cold. It may be added that during the past seven years the temperature of July has been above its average respectively 2·8,° 1·7,° 2·0,° 0·2,° 1·7,° 1·0,° and 1·8,° and that of December, as compared with its average +1·5,° −4·2,° −5·6,° −1·1,° −0·8,° +3.4,° and −7 4;° results quite in the opposite direction of the popularly entertained belief that the summers are colder and the winters milder than formerly."

3. *On the Periodicity of Thunder-storms* (*Ueber gesetzmässige Schwankungen in der Häufigkeit der Gewitter während langjähriger Zeiträume*); by W. v. Bezold.—Von Bezold, in his study of the periodicity of thunder-storms, made use of a series of observations that extended over a period of 105 years (1764–1869) at one locality (Kremsmünster, Bavaria) almost without a break, and of others less complete at other places.

His conclusions he expresses as follows. In years when the temperature is high and the sun's surface relatively free from spots, thunder-storms are abundant. Since, moreover, the maxima of the sun-spots coincide with the greatest intensity of auroral displays, it follows that both groups of phenomena, thunder-storms

and auroras, to a certain extent supplement each other so that years of frequent storms correspond to those auroras, and *vice versa*. He observes that such a connection between sun-spots and storms does not by any means sanction the supposition of a direct electrical interaction between the earth and sun, but may be simply a consequence of a degree of insolation dependent upon the sun-spots.

These changes in the insolation, according to Köppen, manifest themselves in different latitudes not cotemporaneously but successively. The phenomena of thunder-storms, on the other hand, do not depend alone upon the condition at the place in question with respect to temperature, but also on the condition of the atmosphere at points far distant and belonging to another zone. This appears most distinctly in the storms which accompany electrical displays. The peculiar intermediate position which the weather curve takes between the curves of sun-spots and temperature may possibly find its explanation in this fact.

Von Bezold closes with showing that observations recently published in Saxony confirm in a striking manner the conclusions he had reached.—*Ber. Ak. München*, Nov. 7, 1874. E. S. D.

4. *The Blind Fish and some of the associated species of the Mammoth Cave, Kentucky, probably of Marine origin.*—Mr. F. W. Putnam, in an artical published in the Bulletin of the Essex Institute, vol. vi, No. 12, 1874, remarks as follows on the origin of some of the present inhabitants.

That many, or, with two or three exceptions, nearly all of the thirty or forty species of vertebrates, articulates, mollusks and still lower forms, including a few plants, now discovered in the caves of Kentucky, are of comparatively late introduction, is probable from the fact that they are so closely allied to forms living in the vicinity of the caves. But that the blind fishes, the Chologaster and a few of the lower forms of articulates, as the Lernæan, parasitic on the blind fish, may have been inhabitants of the subterranean streams for a much longer period, is worthy of consideration on the following grounds:

First, the blind fish family has no immediate allies existing in the interior waters,* the only species of the family, in addition to the three found in the Mammoth Cave, being known at present only from the rice ditches of the low coast of South Carolina.

Second, the Lernæan parasite is much more common on marine fishes than on strictly fluviatile species, and is more decidedly a marine than a fresh water form. These facts may therefore be taken as at least indicating the probability of the early origin of some part of the great cave system of the region of the Ohio Valley, and while there may be nothing in the present structure of the caves to indicate their having been formed in part while in contact with salt water, the supposed erosion of the limestone and the

* In common with others I have considered the Heteropygii as belonging to the same order with the Cyprinodontes, but I now have, from further information of their structure, doubts as to their close association with that group. This subject will be presented on another occasion.

modification of the early formed chambers by later action should be carefully considered before it can be denied that the caves were not, in some slight part, for a time, supplied with marine life. Until a specimen of Chologaster, or some other member of the family, has been obtained in the external waters of the Ohio Valley, it is hardly logical to regard the family to which the blind fishes belong as one originally distributed in the rivers of the Ohio Valley, and afterward becoming exterminated in the rivers and only existing in two such widely different localities as the coast of South Carolina and the subterranean streams of the southwestern States. That marine forms of life are found in our fresh water lakes and rivers is known to be the case. The specimen of a shrimp exhibited was secured in the Green River, near one of the outlets of the Mammoth Cave. The fact that in some of the waters of Florida fishes once marine are now confined to the fresh water lakes of comparatively recent formation, and that in the St. John's River, and others of that State, many marine and fresh water species are found associated, are evidence of the change that may take place in the habits of some marine animals, while a recent announcement of the Gobiosoma found in the Ohio River* is another instance of a marine fish living in fresh waters.

5. *Proceedings of the Cleveland Academy of Natural Sciences*, 1845 to 1859. 296 pp. 8vo. Cleveland, Ohio. Published by a gentleman of Cleveland.—The valuable papers which were read from time to time before the Cleveland Academy, previous to 1860, by Dr. J. P. Kirtland, Dr. J. S. Newberry, Col. C. Whittlesey, and others, and which have hitherto been published only in part in any scientific journal, are now for the first time gathered into a volume by the Society. The volume contains among its articles descriptions of species of fossil coal plants by Dr. Newberry, and of recent fishes by Dr. Kirtland, with important notes on the distribution and habits of birds, fishes, butterflies and other species by Dr. Kirtland; a paper on the Allegheny Coal field by Col. C. Whittlesey; notes on the Drift by Dr. Newberry and Col. Whittlesey, and short contributions on other topics of interest, including several valuable letters by Agassiz, Harris, and Bachman.

6. *Annual Record of Science and Industry for* 1874. Edited by SPENCER F. BAIRD, with the assistance of eminent men of science. 666 pp. 12mo. New York, 1875. (Harper & Bros.).—The Annual Record for 1874 by Prof. Baird comes well laden with the scientific news of the year past. A long introductory chapter contains a brief review of the chief stages of progress in the various sciences, theoretical and industrial; and then follow abstracts of various papers in science, announcements of new discoveries, statements of new facts about old discoveries and new illustrations of principles, accounts of scientific expeditions and institutions recently established, an obituary chapter, and a list of new works. The book has facts of interest for all classes of readers.

* Putnam, notice of *Gobiosoma molestum* from the Ohio. Amer. Nat., viii, Feb., 1874.